Indiana Department of Natural Resources – Division of Forestry

Comprehensive

Indiana Forestry Best Management Practices

Monitoring Results

1996-2011

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1996 through 2011

Indiana Best Management Practices Report

I. Executive Summary

Forestry Best Management Practices (BMP) monitoring began in 1966 on 43 sites in the counties that are part of the Lake Monroe Watershed. In the 15 years since, Forestry BMP monitoring has expanded to 671 sites in 64 of Indiana's 92 counties.

The application percentage for the 671 monitored sites in those years is 86.31 percent (Figure 1). This means that 86.31 percent of the BMP practices met the guidelines set forth in the BMP Logging and Forestry Best Management Practices Field Guide.

The effectiveness rate, which is a qualitative measure of the impact on the water resources from the forestry practices carried out on the site, over the history of the Indiana BMP program has been 92.46 percent (Figure 2).

In other words, the effectiveness rate indicates that Forestry Practices had little to no impact on water resources 92.46 percent of the time across all 671 sites.

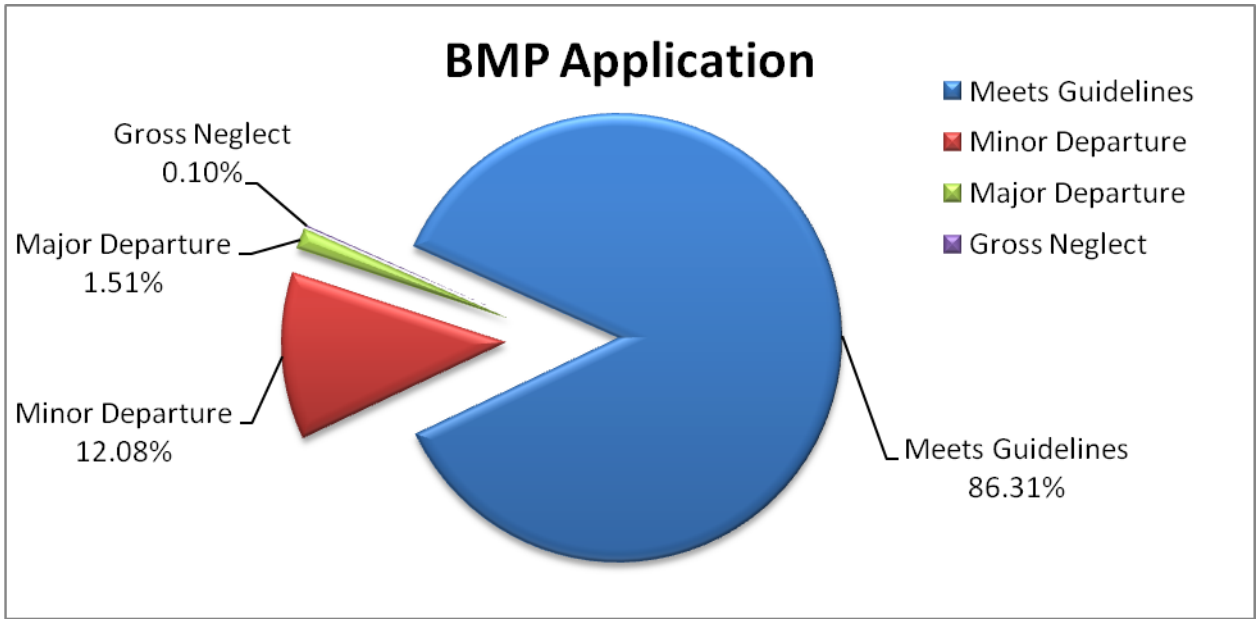

Figure 1. BMP Application for all 671 sites monitored from 1996 – 2011.

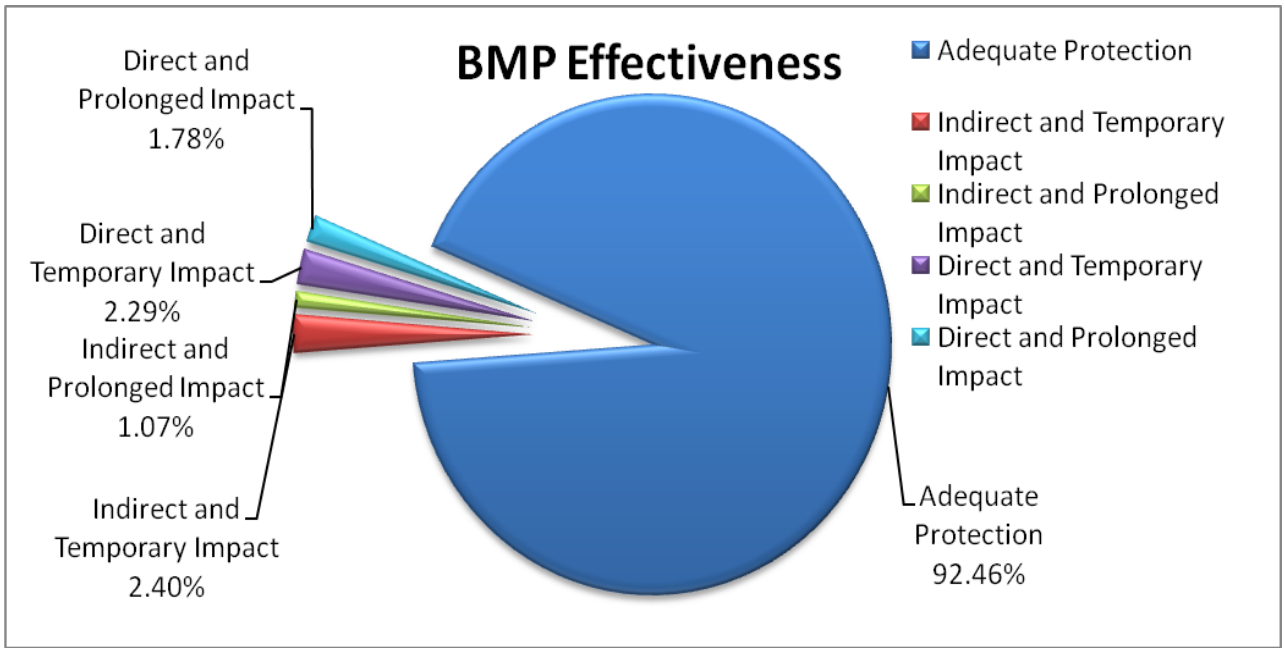

Figure 2. BMP Effectiveness for all 671 sites monitored from 1996 -2011.

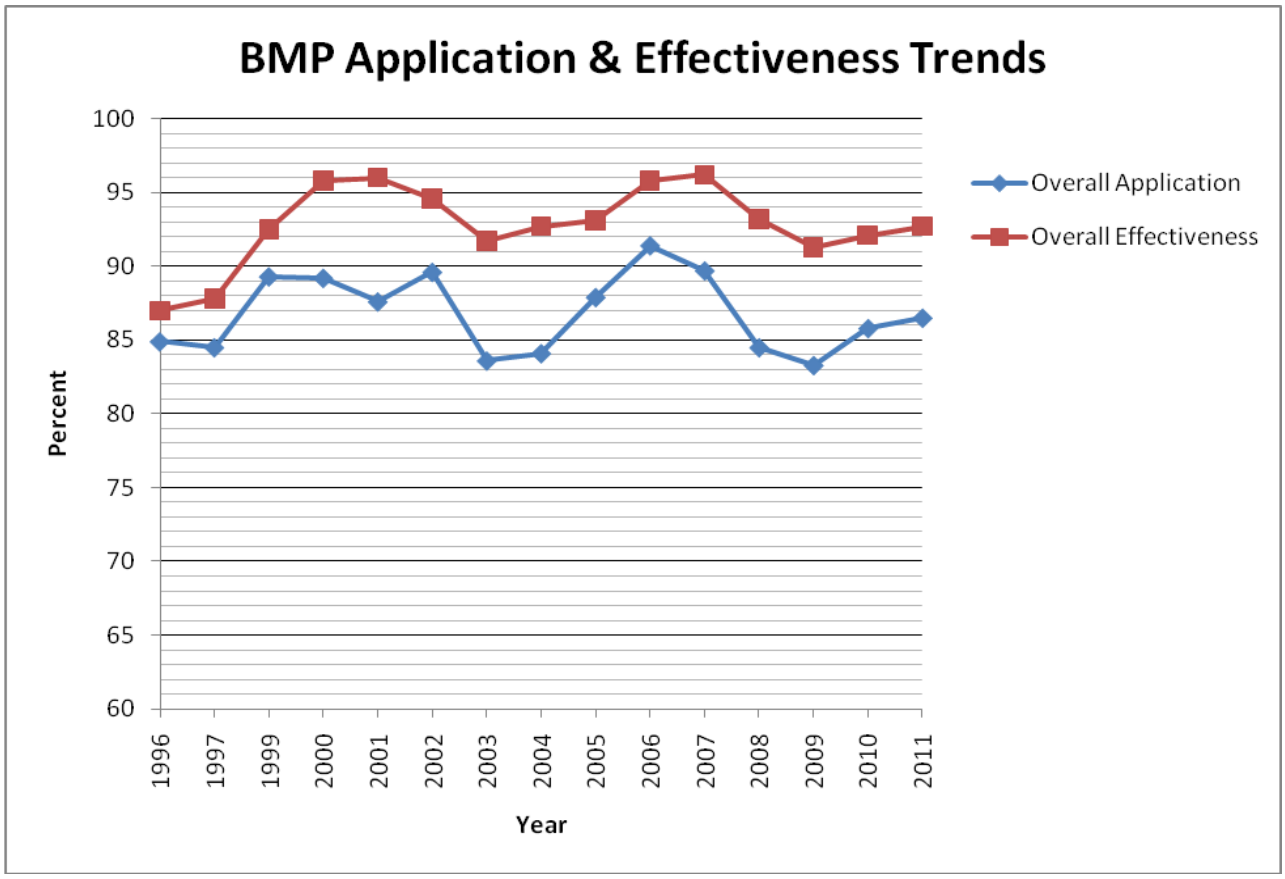

Figure 3. BMP application and effectiveness yearly trends since the beginning of monitoring in Indiana through 2011.

Application and effectiveness rates of sites monitored varied from year to year and no real upward or downward trend can be extrapolated. However, there are several conclusions that can be drawn from Figure 3. First, effectiveness rates are commonly higher than application rates. Second, the rates seem to mirror one another. In most years, when application rates have been lower, the effectiveness rates have dipped as well.

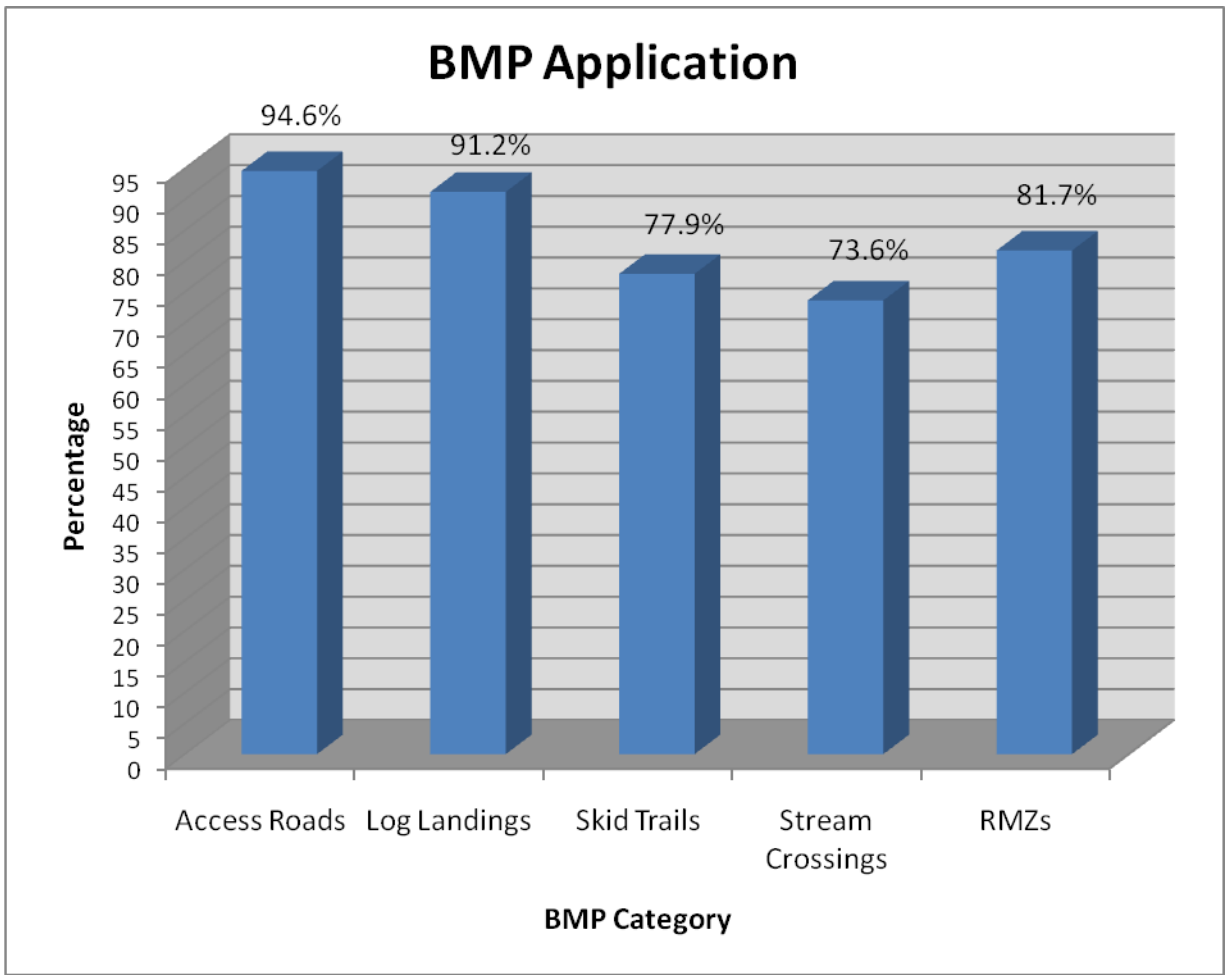

Figure 4. BMP application by BMP category for all 671 sites from 1996 -2011.

There is clear variation when comparing application and effectiveness rates across the five BMP categories: Access Roads, Log Landings, Skid Trails, Stream Crossings and Riparian Management Zones (Figures 4 & 5).

Access Roads score highest in application and effectiveness with Log Landings a close second. RMZs are a distant third. Skid Trail and Stream Crossings received the lowest application scores in both application and effectiveness.

While Skid Trails receive a 77.9 percent application rate, the effectiveness rate was 89 percent, indicating the BMP implementation problems in this category didn't have a significant impact on the water resources of the monitored sites.

Stream Crossings application and effectiveness percentages were both low at 73.6 percent and 78.6 percent respectively. Due to the nature of Stream Crossings, any errors in application can lead to direct impacts to the water resources of the site, so any problems in this area are magnified due to their proximity to water.

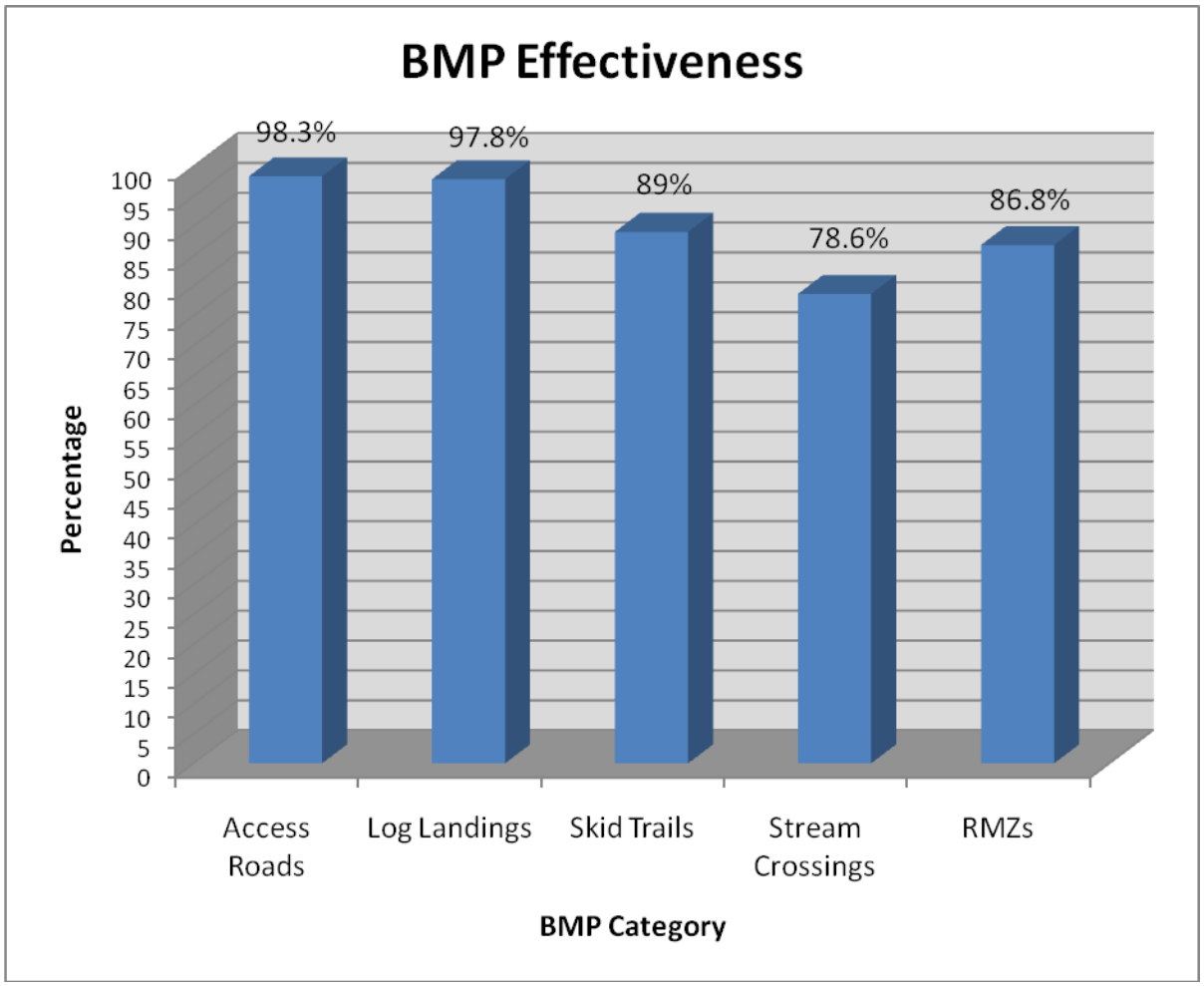

Figure 5. BMP effectiveness by BMP category for all 671 sites monitored from 1996 -2011.

Skid Trails have the largest area of disturbed ground in a timber sale. Therefore it often has the lower application when compared to RMZs, but RMZs have the lower effectiveness scores, likely due to their proximity to water.

Effectiveness is the impact a practice or lack thereof has on water quality. It stands to reason that areas of a timber harvest in close proximity to water have lower effectiveness scores. It is difficult to make assumptions on this data because skid trails that lead to stream crossings and run in RMZs are often similar in application as the rest of the harvest area but get lower scores in effectiveness because the overland flow in these areas goes into the water because it is close by with little buffer to catch the overland flow before it reaches the water body.

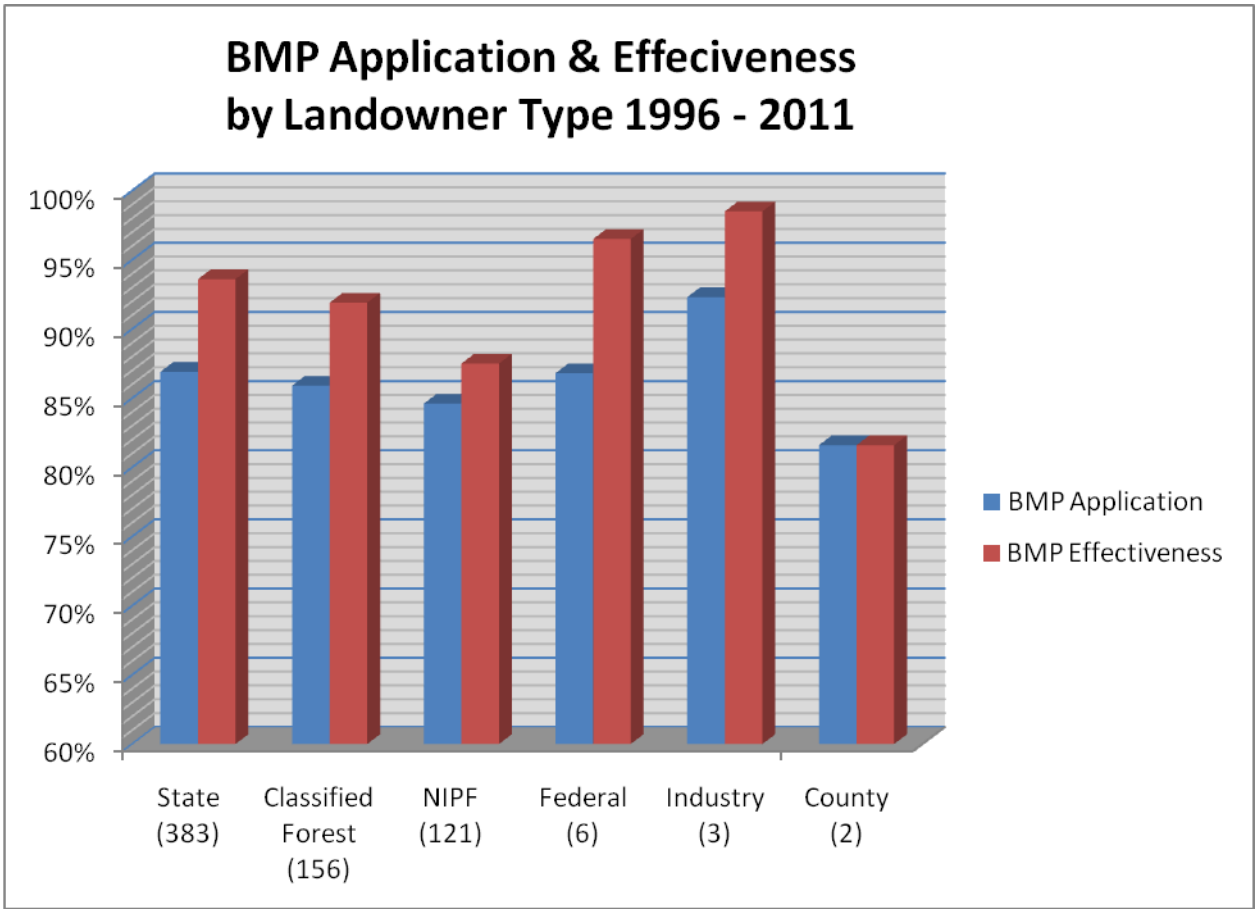

Figure 6. BMP application and effectiveness of all sites monitored from 1996 – 2011 broken down by land ownership.

Forestry BMP application and effectiveness also varied by ownership type. This variation is difficult to draw correlations from due to the difference in site selection and monitoring methodology by landowner type and other factors.

A case in point is the time period when the monitoring of State Forest Property sites had one important difference from the other landowner types but still often came out higher in application as well as effectiveness. State Forest Properties were monitored with the 4-foot Rule (Appendix A) for all timber sales starting July 1, 1999 through June 30, 2010. This gave those sites lower application and effectiveness scores when other landowner types may not have gotten them.

Starting July 1, 2010, the 4-foot Rule was removed and all BMP monitoring defined large intermittent and perennial streams as starting where the U.S. Geological Survey classifies a stream as an intermittent, thus putting all landowner types on the same definition and aligning the findings of all Forestry BMP monitoring in Indiana.

II. Introduction & Indiana Forestry BMP History

A. BMP Introduction

Indiana has 5.1 million acres of forestland, 22 percent of the state's land base, that provide many benefits to Indiana residents and wildlife. Forestland provides Hoosiers various forms of recreation, including hiking, biking, hunting, fishing and wildlife watching. Indiana residents who don't partake in these activities benefit greatly from the clean air and water our forests produce.

Since forests are important to all Indiana citizens, it is imperative that timber harvesting on all ownerships is done in a way that reduces or mitigates environmental impacts.

Although forests are known to be the best way to reduce nonpoint source pollution (NPS) to waterways, they also can be a source of pollutants. When forest soils are bared, there is opportunity for NPS pollution to occur.

Forestry BMPs are employed to protect forest soils and water quality during and after a harvest.

Forest Ownership	Acres	% of Forestland	% of state	% of ownership type acres monitored	% of total acres monitored
Private	4,054,068	83.93	17.55	0.35	0.30
Federal	379,417	7.85	1.64	0.09	0.01
State	352,138	7.29	1.52	7.75	0.56
Local/Municipal	44,772	0.93	0.19	0.37	0.002

Table 1. Forest land ownership types in Indiana and the percentage of total area of forestland, percentage of state they make up, the percentage of acres of each forest ownership type that has been monitored for Forestry BMPs.

Landowner Type	# Sites Monitored	# Acres Monitored
State	383	27,288
Classified Forest & Wildland	156	8,984
NIPF	121	5,282
Federal	6	355
County	3	100
Industrial	2	66

Table 2. Number of sites and acres monitored by ownership types in Indiana.

Forestry BMPs are a foundation for water quality protection and guidelines to protect water quality during forest operations. The purpose is to minimize the impact of forest activities that may affect soil and water quality.

This report is a summary of the application and effectiveness of BMPs for timber harvests conducted on forest properties statewide from 1996 – 2011 on all land ownership types. Data covers all BMP monitoring for 671 sites over those years, looking at time trends and making comparisons.

B. BMP History

The Federal Clean Water Act amendments of 1987 prompted states to develop guidelines to control the impacts of silvicultural practices and other land uses such as agriculture and development that caused nonpoint source pollution (NPS).

In response, the DNR Division of Forestry – along with U.S. Environmental Protection Agency (EPA), Indiana Department of Environmental Management (IDEM), and the Woodland Steward Institute – had a series of meetings with public agencies and private interests. From these meetings, committees were established to develop practices designed to mitigate or minimize impacts of forest management activities on water quality; sometimes even enhancing water quality.

Called "The Forestry Health Initiative," the project completed the guidelines in 1995. The first round of BMP monitoring was done in 1996, and the Forestry BMP Field Guide was published in 1998.

Indiana's Forestry BMP program had three main parts. The first was the BMP Guidelines, which were the physical practices, such as water diversion spacing or seed mixture recommendations and published in the Indiana Forestry BMP Field Guide. The second part was BMP training, which consisted of teaching the BMPs to different segments of the Indiana forest products community, such as loggers, landowners and foresters. The third part was BMP Monitoring, which consisted of looking at how BMPs were applied in the field and how well they protected water quality.

Selected monitoring sites were predominately within the watershed of Lake Monroe, a reservoir serving as a chief source of water and recreation for many Hoosiers. Additional sites were from adjoining Owen County and Morgan-Monroe State Forest. Only legitimate forest sites larger than 10 acres in size and logged within the previous two years were considered for that round of monitoring.

Potential monitoring sites were identified by aerial reconnaissance and ground verification, licensed timber buyer records, district and consultant forester recommendations and Monroe County logging permit records. Owners of prospective sites were contacted to seek permission to use their sites for the study.

Once sites were accepted for monitoring, teams were formed with people from diverse technical backgrounds. A DNR forester led each team to provide technical and logistic support. Other team members came from the forest industry, environmental community, landowners, planning

and development, wildlife biology, hydrology and soil conservation. Team size was 4 to 5 individuals, often with team members possessing multiple areas of expertise.

All BMP monitoring since has followed the model set in the mid-1990s with changes over time by necessity or to improve recognized needs.

The first few rounds of monitoring were paid for through money from IDEM, the Great Lakes Commission under the Clean Water Act, or some other federal program. BMP monitoring has also become a staple on state forest harvest sites where all harvests are now monitored for BMP compliance.

III. Methods

A. BMP Monitoring Objectives

BMP monitoring has five objectives:

(1) To assess the effectiveness of BMP guidelines in minimizing soil erosion and stream sedimentation;
(2) To provide information on the extent of BMP implementation, past and current;
(3) To identify areas to focus future program training and educational efforts to improve BMP implementation and effectiveness;
(4) To identify BMP specifications that may need technical modification; and
(5) To identify improvements needed in future monitoring efforts.

B. Site Selection

State Forest: Every timber harvest conducted on state forest property is monitored if the timber was sold after July 1, 1999, unless the harvest occurred in order to change the land use. For example, Ferdinand State Forest had a site where timber was harvested before the area was cleared for a pipeline right-of-way. This kind of land-use change makes it impossible to monitor for forestry BMPs. It was determined in 2007 that 10 percent of state forest sites monitored the two previous years and every year thereafter would be re-monitored for quality-control purposes. Sites were given numbers, and then the numbers were chosen randomly to select the 10 percent of sites to be re-monitored.

Classified Forest and Wildland: Beginning in 2008, at least 10 percent of Classified Forest and Wildland (CFW) Program sites reported as having a harvest the previous year have been monitored. CFW monitoring began in order to make Classified Forest and Wildland properties eligible for certification with the Forest Stewardship Council (FSC). Sites are randomly selected from required annual reports for properties in the program that have had a harvest during the year they are reporting. Once the annual reports are submitted, each timber harvest in each district is

given a number, which is run through a random number generator. Harvests that make up at least 10 percent of the harvests in each district are then monitored. For instance, if a district gets back 31 annual reports of a harvest in that year, the first four sites selected by the random number generator will be monitored.

Random Forests: From 1996 through 2004, monitoring sites other than state forests were selected by geographic position. The 1996 and 1997 rounds were in counties that had land in the Lake Monroe watershed; the 1999 round was in five randomly selected counties (Ohio, Jefferson, Clay, Martin and Steuben); and the 2000 round looked at sites in seven of the 13 counties that have watersheds flowing into the Great Lakes (Adams, Allen, Elkhart, LaGrange, LaPorte, Noble, and Steuben). One site in 1996, six sites in 1997, and five sites in 1999 were recorded as being Classified Forest and Wildland properties. Other landowner types included Non-Industrial Private Forests (NIPF), County, Federal and Industrial.

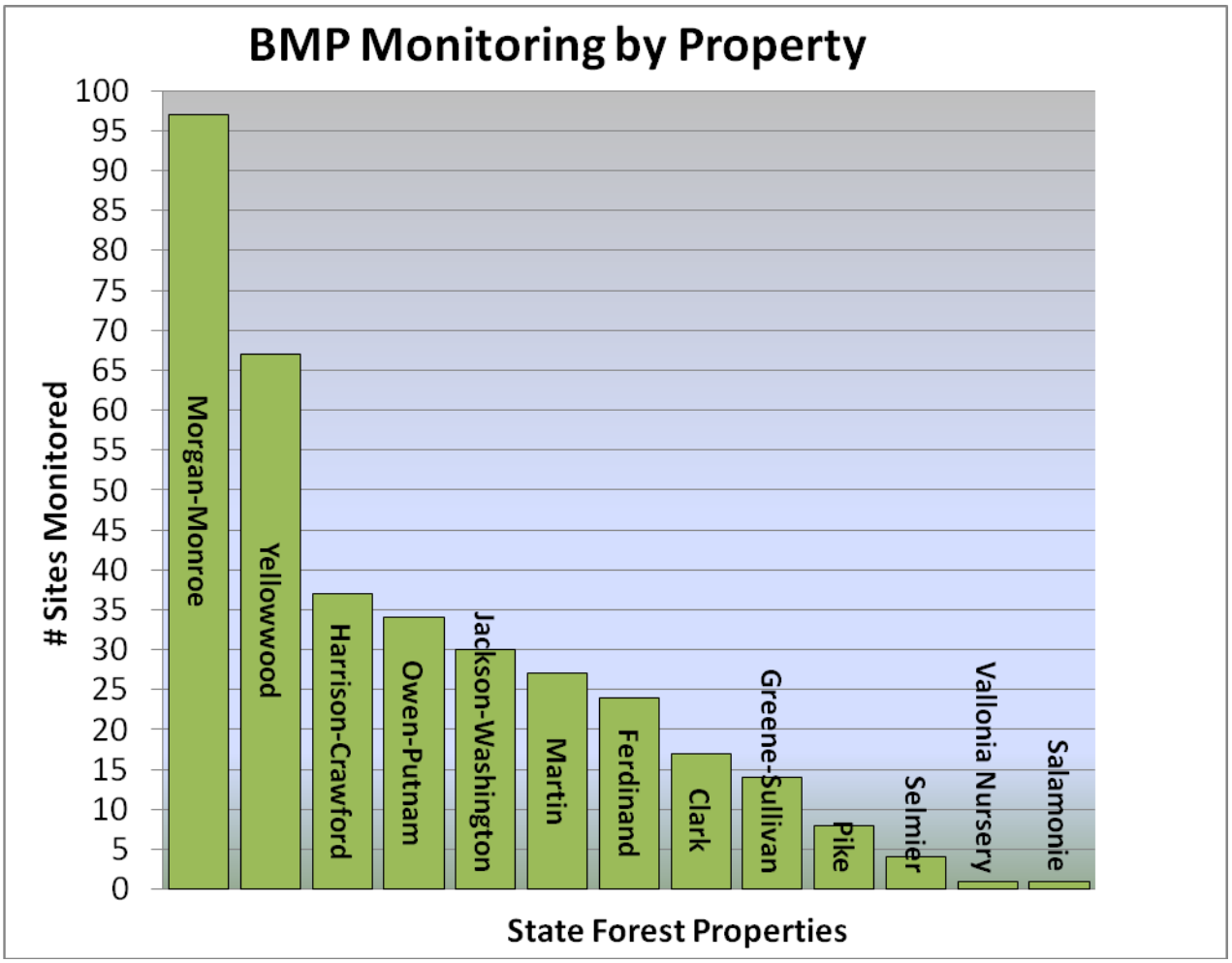

Figure 7. Timber harvests monitored for BMPs in Indiana State Forests by property.

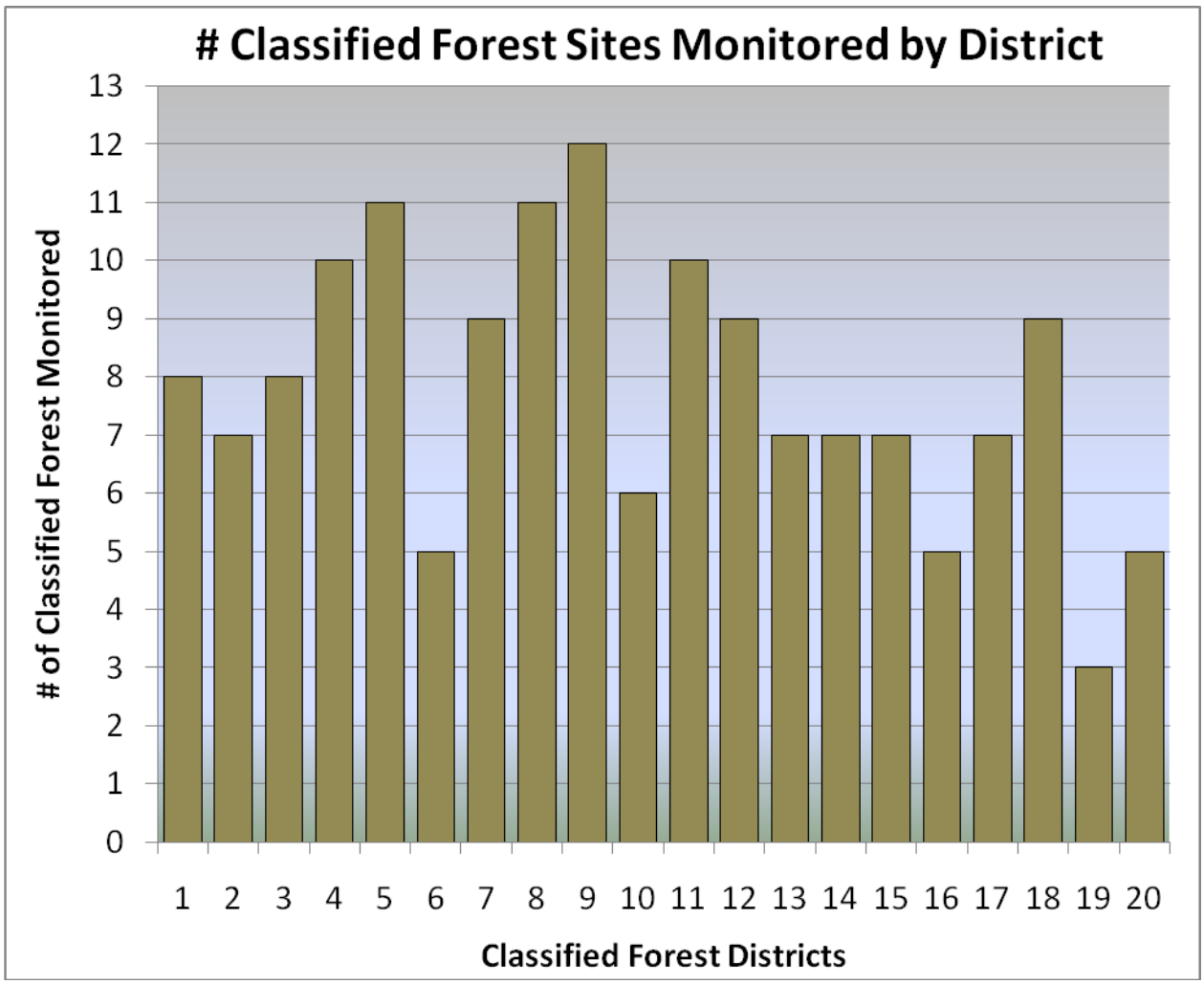

Figure 8: Number of Classified Forest timber harvest sites monitored for BMPs by district.

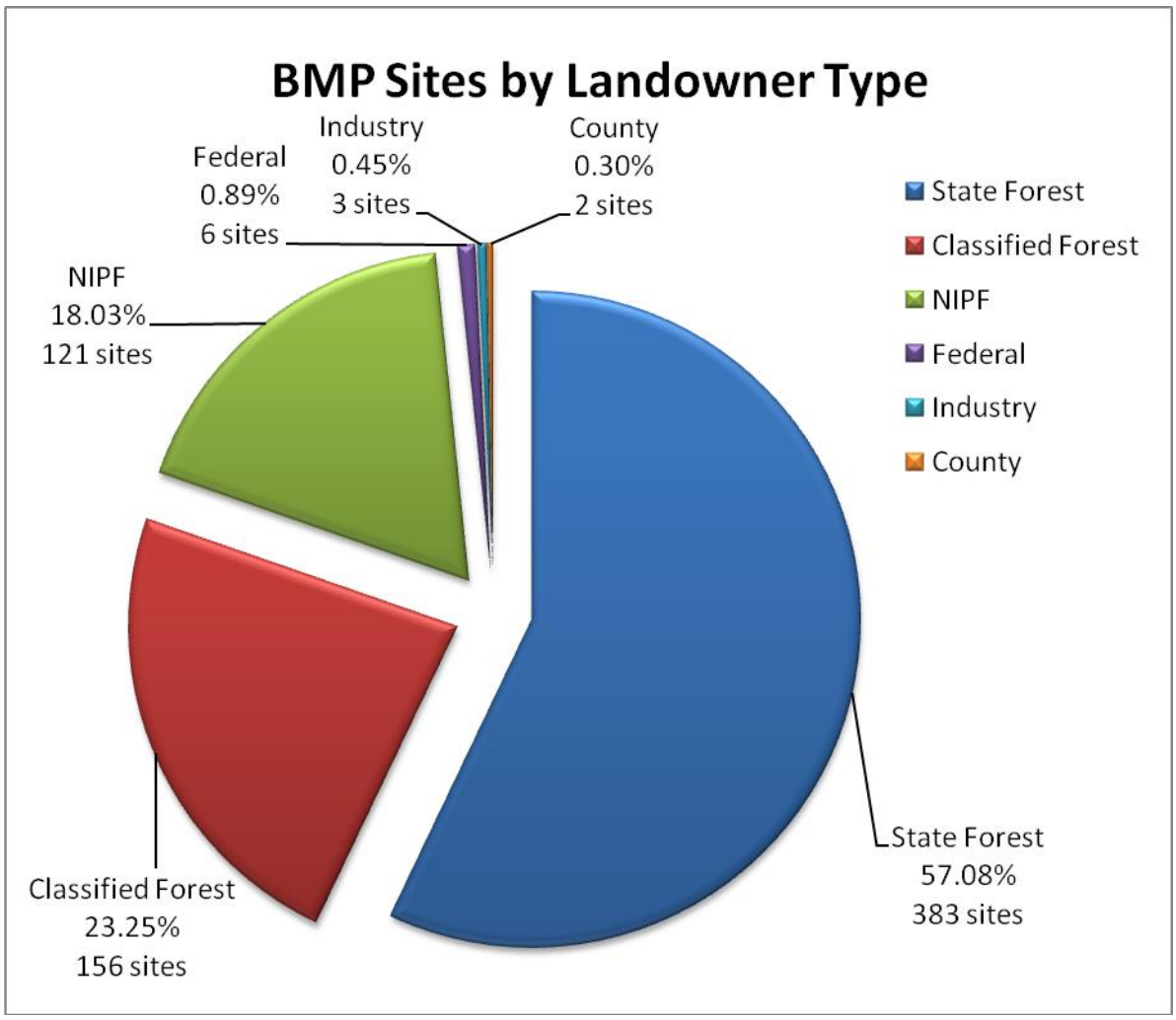

Figure 9. Proportion of land ownership type for total number of sites monitored.

C. Data Collection, Entry and Analysis

The BMP Monitoring Form (Appendix B) is used to collect data both in the office and field. Much of the first page can be completed by consulting maps, harvest paperwork and/or talking to the forester, timber buyer or landowner. The remaining pages of the form are completed in the field during and following the site evaluation. More details about that process can be found below in the "Site Evaluation" section.

These "raw" data sheets are brought to the office and given to a Division of Forestry employee to enter into the Indiana Forestry BMP Database. Datasheets are edited and copies are supplied to concerned parties: foresters, landowners, timber buyers, and managers. The data also is used to generate various reports, such as this one and annual reports for state forest, classified forest and quality control.

D. Monitoring Team Selection

Selection of team members has been modified over the course of Forestry BMP monitoring in Indiana (1996 -2011). It also has varied based upon the landownership and monitoring objectives.

State Forests: Initially, either or both the Watershed Conservation (WC) and Licensed Timber Buyers (LTB) Foresters came to every BMP monitoring site on State Forest properties. This kept a balance for consistency in the monitoring and resulting data.

From July 1999 until 2003, the Property Specialist coordinated monitoring dates and people, and also attended the monitoring of every timber harvest. This practice was discontinued when administrative duties increased for that position and coordination of monitoring was passed to the LTB Forester.

Team now consist of a BMP Monitoring staff that includes the LTB Forester and one or two intermittent positions whose focus is BMP monitoring. The other participants are the Administering Forester, and at times, other foresters on the property. This provides balance in the monitoring process and provides good training and discussion.

Third Party Quality Control: The third party team needs to have at least two or three people who could take the time to visit the 22 sites together. The team represented an array of interested parties from outside state government.

Ownership other than State: An assortment of technical backgrounds was the basis for monitoring team selection from 1996-2004. A DNR forester led each team to provide technical and logistic support. Team members also included individuals from the forest industry, the environmental community, landowners, planning and development staff, wildlife biology, hydrology, loggers and soil conservation. Team size was four to five individuals, often with team members possessing multiple areas of expertise.

Classified Forest: In the 2008-2011 monitoring of Classified Forest sites, the District Forester and one or more of the BMP monitoring staff monitored each site. If the landowner or harvesting professional came as well, they were included.

E. Site Evaluation

BMP monitoring is based on the evaluation of each practice for application and effectiveness. Application is the installation of a practice and the condition of the practice at the time of monitoring. Effectiveness is the level of success a practice has in the prevention of pollutants entering a water body or the level of impact the pollutant is having on the water body at the time of monitoring.

It is possible to apply all of the BMPs properly and get a good score in application but still have soil entering a stream, which would call for a lower score in effectiveness. The opposite may be possible as well.

There are 53 individual BMPs measured for application and effectiveness on each site evaluation. These individual BMPs are within five categories:

- Access or Haul Roads
- Log Landings or Yards
- Skid Trails
- Stream Crossings
- Riparian Management Zones (RMZ)

The team inspects the harvest area, covering all five categories as suggested in the Indiana BMP Monitoring Protocol, and commenting on successes and departures from the BMP guidelines.

The monitoring team walks the area and its adjacent and interior intermittent or larger streams. The team carries maps of the site, the BMP monitoring form and the BMP Field Guide, which allows each team member to evaluate the BMPs on the site. Once the team has walked the area, they meet to discuss each question and each team member's scores on the BMP monitoring form until consensus is reach for scores on each question.

On state forest properties, between 1999 and 2010, the definition of large intermittent streams was focused on streams that were 4-feet wide at the bed of the stream or marked as mapped intermittent streams, or larger, on U.S. Geological Survey quadrangle maps. This was done to more easily determine what streams need to be monitored for the presence of large woody debris caused by the harvest that must be removed. A better history and definition for streams that qualified as four feet is in Appendix A.

The "4-Foot Rule" (Appendix A) was adopted as an automatic intermittent stream starting July 1, 1999 when BMPs officially were put in state timber sale contracts. On other forest ownership types, the definition of an intermittent was defined in the BMP Field Guide and how the monitoring crew interpreted what it saw on the site. As of July 1, 2010, the "4-Foot Rule" gave way to consistency with the other property ownership types as far as stream crossings were concerned. With this rule, there were streams on State Forest properties that had woody debris in them that was required to be removed that would not have been counted against them on other ownership types. Now all the ownership~~s~~ types are consistent in this matter

Quality Control

It was determined in early 2006 that an external or third-party audit of BMP monitoring on Indiana State Forest properties would be conducted every year in perpetuity to ensure the

accuracy of the Division of Forestry's internal audits. A yearly report of the auditors' findings can be reviewed online at www.in.gov/dnr/forestry/files/fo-1996_2009BMP.pdf .

Ten percent of sites monitored each year are to be reviewed. At this time there is no consistent quality control monitoring on forests of land ownerships other than State Forests. Quality control evaluation was made on the statewide regional monitoring conducted in 2005. No such monitoring endeavor of mixed ownership types has occurred since then.

IV. Results

A. Comprehensive BMP Application & Effectiveness

The application and effectiveness rates for forestry BMPs used to protect sites after timber harvests are excellent for the 671 sites monitored since 1996. The overall application rate is 86.31 percent and the overall effectiveness rate is 92.46 percent (Figures 10 and 11).

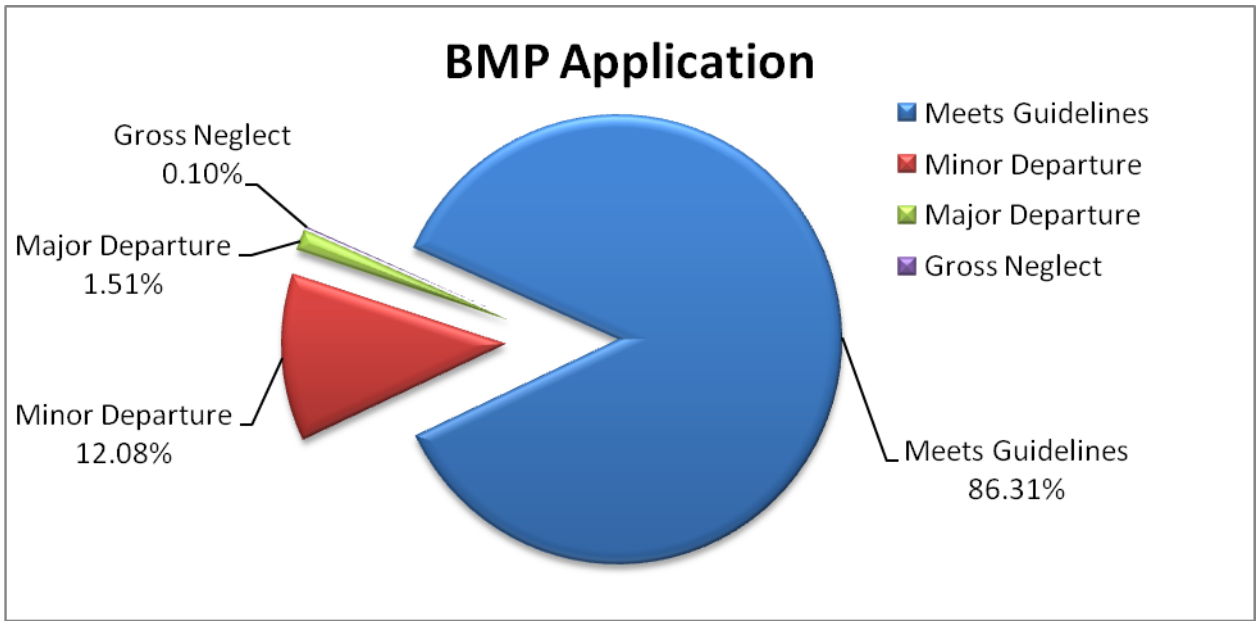

Figure 10. BMP Application for all 671 sites monitored from 1996 – 2011.

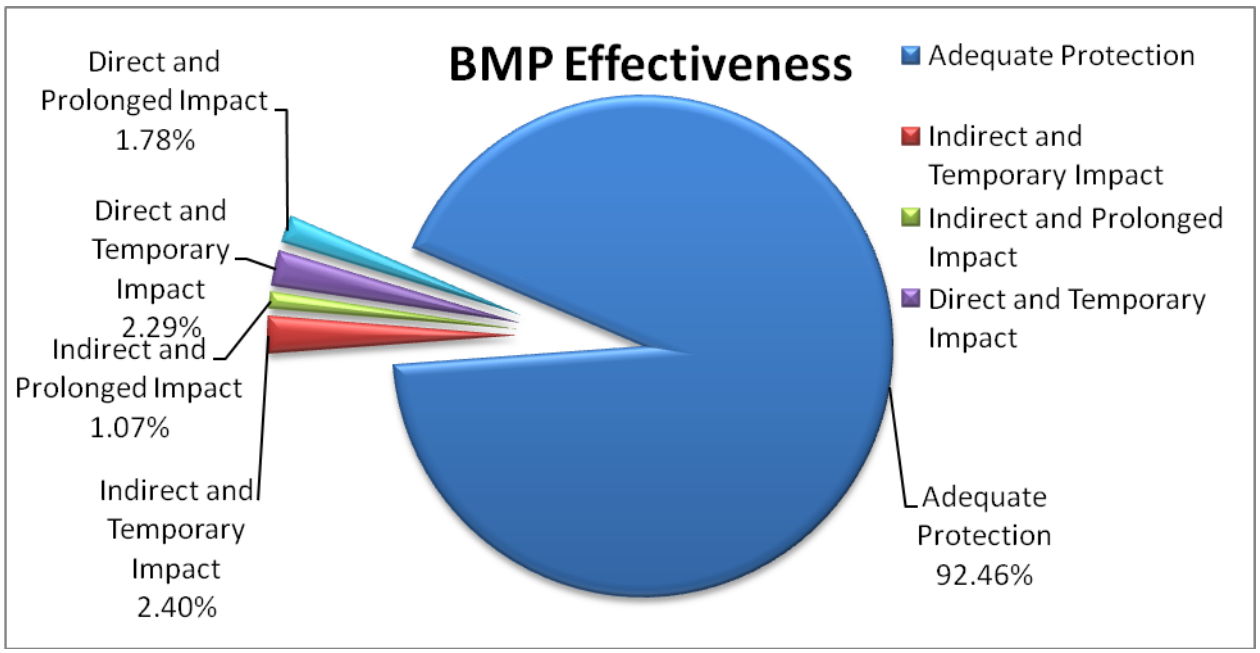

Figure 11. BMP Effectiveness for all 671 sites monitored from 1996 -2011.

B. Application & Effectiveness of BMPs by Category

BMP application trends (Figure 12) remain consistently high for access roads and log landings through the 15 years of monitoring. RMZ application got off to a slow start the first two years of monitoring, staying between 75 -80 percent, but after that never dropped below 80 percent, except for 2009.

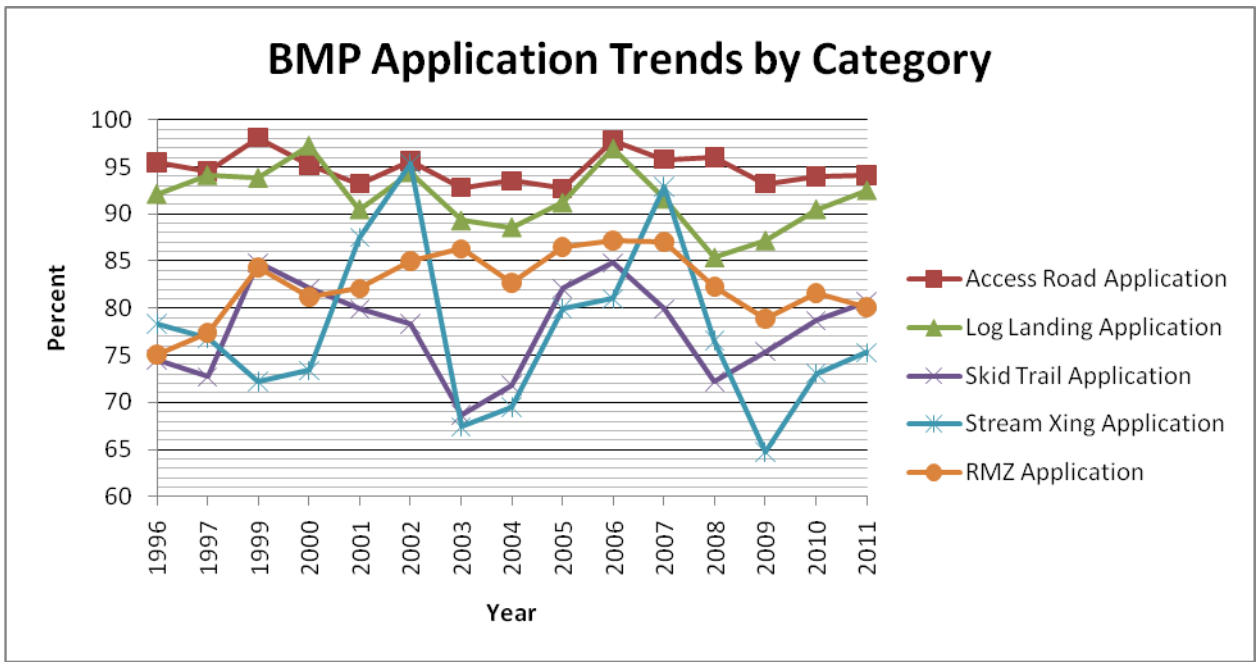

Figure 12. Yearly BMP application trends by BMP category.

The application rate for RMZs has been on the decline in the last four years. The last rating is 81.6 percent. Skid trails and stream crossings are the most challenging part of the majority of timber harvest. The application trend lines for both of these BMP categories fluctuate widely across the monitoring term. Stream crossings are the most erratic, fluctuating from 95.3 percent at its highest point in 2002 and 64.7 percent at its lowest point in 2009.

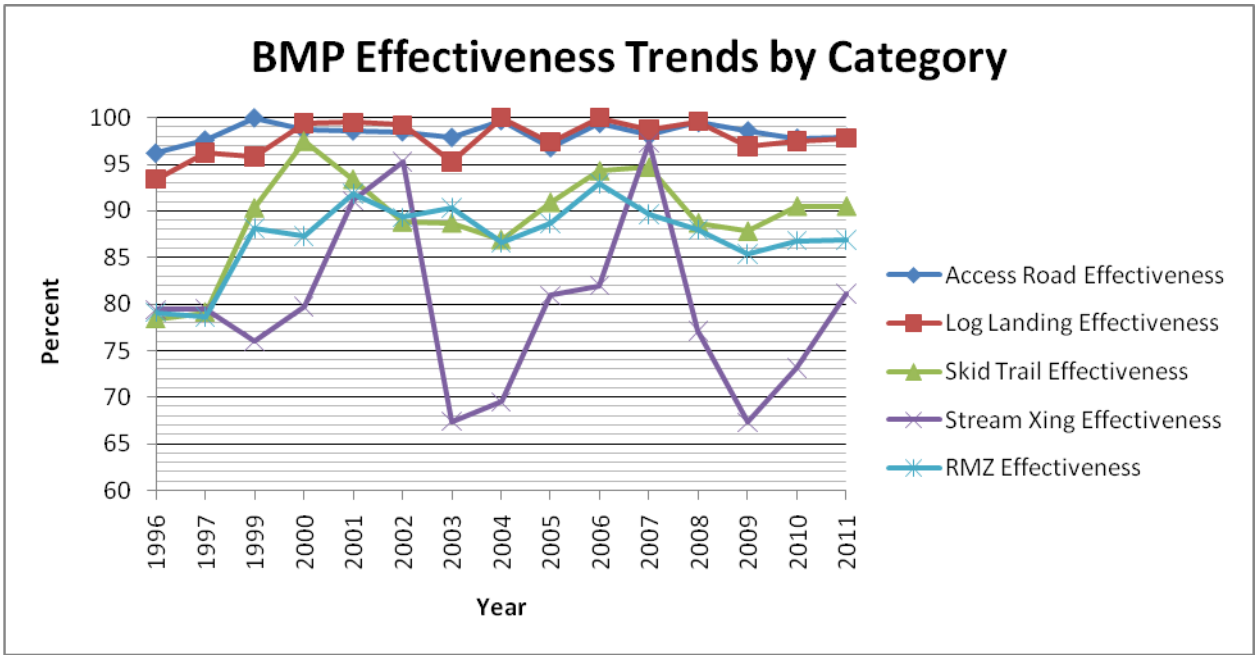

Figure 13. Overall BMP effectiveness yearly trends by BMP Category.

The BMP effectiveness trends closely mimic the application trends; however, the effectiveness rates are generally higher than application rates (Figure 13).

As with application, effectiveness rates for access roads and log landings are consistently high.

Skid trails show the most variation between application and effectiveness. While application had many ups and downs, skid trail effectiveness is much more consistent. It seems after a bit of a learning curve of the first two years (78.4 percent and 79 percent respectively), that effectiveness of skid trails became much improved and percentages ranged from the mid 80s to the high 90s.

RMZ effectiveness was very similar to application, although it ranged a few percentage points higher.

Stream effectiveness closely mirrored the application percentages and remained erratic.

BMP	State		Classified		NIPF	
	% Application	% Effectiveness	% Application	% Effectiveness	% Application	% Effectiveness
Access Road	94.8	98.4	92.8	99.0	95.5	97.0
Log Landing	90.1	98.5	92.6	98.3	93.0	94.6
Skid Trail	77.3	89.9	77.7	88.9	75.9	82.3
Stream Crossing	79.7	82.0	68.8	71.1	73.1	74.8
RMZ	84.3	88.9	77.6	85.7	73.9	78.7
Overall	86.9	93.6	84.6	91.8	84.6	87.5
BMP	**Federal**		**Industry**		**County**	
	% Application	% Effectiveness	% Application	% Effectiveness	% Application	% Effectiveness
Access Road	86.7	100.0	90.9	100.0	N/A	N/A
Log Landing	87.5	94.6	100.0	96.2	100.0	94.6
Skid Trail	80.0	92.7	84.0	100.0	68.4	100.0
Stream Crossing	100.0	100.0	N/A	N/A	N/A	N/A
RMZ	93.9	97.0	100.0	100.0	0.0	0.0
Overall	86.8	96.5	92.3	98.5	81.6	81.6

Table 3. BMP category application and effectiveness by land ownership.

While it is impossible to make any direct correlation between landowner types due to the different site selection methods used, there is still useful data from these sources (Table 3).

We can say conclusively that across all landownership types, effectiveness rates are always higher than application rates. This indicates that although BMPs may not be applied perfectly there is still satisfactory safeguard being provided to the water resources of the site.

Federal, industry and county ownerships only had six, three and two sites monitored, respectively, and thus do not provide a clear picture of the status of BMPs on timber harvest of those ownerships.

State, classified and non-industrial private forests had 383, 156 and 121 sites monitored, respectively. These numbers give a better "snapshot" of BMPs on timber harvest of these ownership types. State forests have the highest overall application (86.9 percent) and effectiveness (93.5 percent) rates compared to Classified and NPIF. Classified and NPIF had the same application rate at 84.6 percent. Classified forest had the highest effectiveness rates of the two at 91.8 percent compared to 87.5 percent for NPIF.

The five BMP categories had many similarities between ownership types. There also were notable differences.

Similarities were Access Road and Log Landing, which were areas of high implementation for all ownership types.

Rates were almost identical for Skid Trail on State and Classified forest at 77 percent application and 90 and 89 percent effectiveness, respectively. However, Skid Trail on NIPFs scored 76 percent for application and 82 percent for effectiveness.

Larger gaps in application and effectiveness between these three ownerships are seen in the Stream Crossing and RMZ categories. The State Forest application score for Stream Crossing was 79.7 percent and effectiveness was 82 percent. Classified forest Stream Crossing had the lowest application and effectiveness rates at 68.8 percent and 71.1 percent effectiveness. NIPF scored 73.1 percent for application and 74.8 percent for effectiveness in Stream Crossing.

RMZ for these three ownerships followed a similar pattern, with State Forests having a higher application and effectiveness rate than classified or NPIF. Conversely, in RMZs, NIPF had the lowest application (73.9 percent) and (78.7 percent).

BMP	Overall	
	% Application	% Effectiveness
Access Road	94.6	98.3
Log Landing	91.2	97.6
Skid Trail	77.9	89.1
Stream Crossing	76.3	78.6
RMZ	81.7	86.8
Overall	86.3	92.5

Table 4. Overall application and effectiveness by BMP Category.

In the overall BMP application and effectiveness for the five categories, Access Road and Log Landing were again the highest ranked.

Access Road had a 94.6 percent application rate and 98.3 percent effectiveness rate. Log Landing application rate was 91.2 percent and effectiveness 97.6 percent. The third highest category was RMZ with 81.7 percent application and 86.8 percent effectiveness rates.

Skid Trail ranked next to last with 77.9 percent application and 89.1 percent effectiveness.

The BMP area with the most difficulty was Stream Crossing. Because of the direct impact all crossings can have on water resources, BMP application and effectiveness is most critical in this area. Small application problems can lead to large-scale disturbance to the streams.

The application of stream crossings across the 15 years of monitoring, on all land ownerships, is 76.3 percent and 78.5 percent effectiveness.

1. Access Roads

Table 5 depicts the breakdown of each individual BMP specification in the area of access roads from all 671 sites monitored across the 15-year monitoring period. With this table and each

successive table, the individual BMPs that were deemed to be challenging (lowest scores) will be discussed.

Three BMPs had application issues. Those were the A8 (Proper placement of excavated material, 86.4 percent), A9 (Roads constructed to drain well, 82.5 percent), and A14 (Maintaining the public road drainage system, 87.3 percent). These minor problem areas seemed to have little effect on the water resources of the site as all had 97 percent effectiveness or above.

Comprehensive Access Roads		**% Applications**	**% Effective**
A1	Uses existing routes where appropriate	99.5	99.8
A2	Adequate buffer strip next to watercourses and sensitive areas	94.5	98.6
A3	Avoids unstable gullies, seeps, very poorly drained areas	94.2	98.6
A4	Road grades are within standards	97.7	99.8
A5	Amount of roads minimized	99.6	100.0
A6	Stream crossings minimized	99.6	99.6
A7	Road excavation minimized	98.7	99.6
A8	Excavated and fill materials placed properly	86.4	99.0
A9	Roads constructed to drain well	82.5	97.0
A10	Appropriate stabilization, drainage and diversions installed	90.0	94.0
A11	Water diversions functioning properly	89.9	95.6
A12	Runoff diverted onto stable forest floor areas	99.4	93.6
A13	Mud kept off of public road	99.6	99.4
A14	Public road's drainage maintained	87.3	99.8
A15	Traffic barriers installed	92.3	99.4
	Overall Percentage	94.6	98.3

Table 5. Overall Access road application and effectiveness from all 671 sites monitored from 1996 -2011.

State Access Roads		**% Applications**	**% Effective**
A1	Uses existing routes where appropriate	99.7	99.7
A2	Adequate buffer strip next to watercourses and sensitive areas	94.7	98.8
A3	Avoids unstable gullies, seeps, very poorly drained areas	94.0	98.6
A4	Road grades are within standards	97.4	100.0
A5	Amount of roads minimized	99.7	100.0
A6	Stream crossings minimized	100.0	100.0
A7	Road excavation minimized	98.6	99.7
A8	Excavated and fill materials placed properly	98.8	99.1
A9	Roads constructed to drain well	84.3	96.9
A10	Appropriate stabilization, drainage and diversions installed	82.5	94.6
A11	Water diversions functioning properly	89.5	96.5
A12	Runoff diverted onto stable forest floor areas	88.6	92.7
A13	Mud kept off of public road	99.1	99.4
A14	Public road's drainage maintained	100.0	100.0
A15	Traffic barriers installed	95.9	99.4
	Overall Percentage	94.8	98.4

Table 6. Access road BMP application and effectiveness for all state sites monitored from 1996 -2011.

State access road problem areas (Table 6) were A9 (Roads constructed to drain well, 84.3 percent), A10 (Appropriate road stabilization, drainage and diversions installed, 82.5 percent)

and A12 (Runoff diverted to stable forest floor, 88.6 percent). Effectiveness on these areas was still high at 92.7 percent and above.

Classified Access Roads		% Applications	% Effective
A1	Uses existing routes where appropriate	98.7	100.0
A2	Adequate buffer strip next to watercourses and sensitive areas	90.0	98.6
A3	Avoids unstable gullies, seeps, very poorly drained areas	90.5	97.3
A4	Road grades are within standards	98.7	100.0
A5	Amount of roads minimized	100.0	100.0
A6	Stream crossings minimized	98.5	98.5
A7	Road excavation minimized	100.0	100.0
A8	Excavated and fill materials placed properly	98.5	100.0
A9	Roads constructed to drain well	85.3	98.7
A10	Appropriate stabilization, drainage and diversions installed	77.6	95.5
A11	Water diversions functioning properly	96.0	98.0
A12	Runoff diverted onto stable forest floor areas	92.5	98.1
A13	Mud kept off of public road	100.0	100.0
A14	Public road's drainage maintained	98.6	100.0
A15	Traffic barriers installed	65.2	100.0
	Overall Percentage	92.8	99.0

Table 7. Access road BMP application and effectiveness for all CLFW sites monitored from 1996 -2011.

Classified forests also had three areas of application concern (Table 7). They were A9 (Roads constructed to drain well, 85.3 percent), A10 (Appropriate road stabilization, drainage and diversion installed, 77.6 percent) and A15 (Traffic barriers installed, 65.2 percent).

However, the effectiveness rate was 98.7 percent for A9, 95.5 percent for A10 and 100 percent for A15, the latter showing that the application caused no problems on classified forests.

NIPF Access Roads		% Applications	% Effective
A1	Uses existing routes where appropriate	100.0	100.0
A2	Adequate buffer strip next to watercourses and sensitive areas	96.1	96.2
A3	Avoids unstable gullies, seeps, very poorly drained areas	96.1	97.4
A4	Road grades are within standards	97.6	98.8
A5	Amount of roads minimized	98.8	100.0
A6	Stream crossings minimized	97.0	97.2
A7	Road excavation minimized	98.5	98.5
A8	Excavated and fill materials placed properly	95.6	97.9
A9	Roads constructed to drain well	93.6	94.8
A10	Appropriate stabilization, drainage and diversions installed	85.1	90.0
A11	Water diversions functioning properly	78.1	82.9
A12	Runoff diverted onto stable forest floor areas	91.5	91.2
A13	Mud kept off of public road	100.0	100.0
A14	Public road's drainage maintained	98.6	100.0
A15	Traffic barriers installed	90.2	100.0
	Overall Percentage	95.5	97.0

Table 8. Access Road BMP application and effectiveness for all NIPF sites monitored from 1996 -2011.

NIPF had two areas of concern within access road BMP application rates (Table 8. They were A10 (Appropriate road stabilization, drainage and diversions installed, 85.1 percent) and A11 (Water diversions functioning properly, 78.1 percent).

The A10 effectiveness rate was 90 percent, showing a small amount of impact to water resources. However, the A11 impact was a greater at 82.9 percent effectiveness.

Federal Access Roads		% Applications	% Effective
A1	Uses existing routes where appropriate	100.0	100.0
A2	Adequate buffer strip next to watercourses and sensitive areas	100.0	100.0
A3	Avoids unstable gullies, seeps, very poorly drained areas	100.0	100.0
A4	Road grades are within standards	75.0	100.0
A5	Amount of roads minimized	100.0	100.0
A6	Stream crossings minimized	100.0	100.0
A7	Road excavation minimized	100.0	100.0
A8	Excavated and fill materials placed properly	100.0	100.0
A9	Roads constructed to drain well	66.7	100.0
A10	Appropriate stabilization, drainage and diversions installed	50.0	100.0
A11	Water diversions functioning properly	75.0	100.0
A12	Runoff diverted onto stable forest floor areas	75.0	100.0
A13	Mud kept off of public road	100.0	100.0
A14	Public road's drainage maintained	100.0	100.0
A15	Traffic barriers installed	N/A	100.0
	Overall Percentage	86.7	100.0

Table 9. Access Road BMP application and effectiveness for all federal sites monitored from 1996 -2011.

The six federal sites had several problem areas in access road implementation. A4, A9, A10, A11, A12 all were at 75 percent or below in application. However, the effectiveness rates of all access BMPs on the federal sites were 100 percent, showing no effect to the water resources of the six sites.

Industry Access Roads		% Applications	% Effective
A1	Uses existing routes where appropriate	100.0	100.0
A2	Adequate buffer strip next to watercourses and sensitive areas	N/A	N/A
A3	Avoids unstable gullies, seeps, very poorly drained areas	100.0	100.0
A4	Road grades are within standards	100.0	100.0
A5	Amount of roads minimized	100.0	100.0
A6	Stream crossings minimized	100.0	100.0
A7	Road excavation minimized	100.0	100.0
A8	Excavated and fill materials placed properly	N/A	N/A
A9	Roads constructed to drain well	100.0	100.0
A10	Appropriate stabilization, drainage and diversions installed	N/A	100.0
A11	Water diversions functioning properly	N/A	100.0
A12	Runoff diverted onto stable forest floor areas	N/A	100.0
A13	Mud kept off of public road	100.0	100.0
A14	Public road's drainage maintained	100.0	100.0
A15	Traffic barriers installed	0.0	100.0
	Overall Percentage	90.9	100.0

Table 10. Access road BMP application and effectiveness for the 3 industry sites monitored from 1996 -2011.

The only noteworthy finding on the three industry sites was that no traffic barriers had been installed. However, the effectiveness rate was still 100 percent, indicating that the lack of gates didn't impair the road.

The two county sites monitored had no access roads and therefore no access road data.

2. Log Landings

Comprehensive Log Landings		% Applications	% Effective
Y1	Uses existing routes where appropriate	94.7	99.4
Y2	Adequate buffer strip next to watercourses and sensitive areas	93.2	98.4
Y3	Avoids unstable gullies, seeps, very poorly drained areas	94.7	98.6
Y4	Road grades are within standards	94.4	99.2
Y5	Amount of roads minimized	80.3	96.4
Y6	Stream crossings minimized	83.5	93.7
Y7	Road excavation minimized	88.5	95.7
Y8	Excavated and fill materials placed properly	89.7	97.0
Y9	Roads constructed to drain well	95.0	98.9
Y10	Appropriate stabilization, drainage and diversions installed	97.4	98.6
	Overall Percentage	91.2	97.6

Table 11. BMP application and effectiveness on log landings for all 671 sites monitored from 1996-2011.

Log landings for all 671 sites monitored between 1996 and 2011 had good application and effectiveness scores (Table 11).

Applications Y5 (Landings avoid collecting runoff, 80.3 percent), Y6 (Runoff enters stable area, 83.5 percent) and Y8 (Water diversions in working order, 88.5 percent) had some complications, but all three areas had effectiveness ratings of 93.7 percent or above, indicating no significant impact to water quality.

State Log Landings		% Applications	% Effective
Y1	Uses existing routes where appropriate	92.9	99.5
Y2	Adequate buffer strip next to watercourses and sensitive areas	95.2	99.5
Y3	Avoids unstable gullies, seeps, very poorly drained areas	94.7	100.0
Y4	Road grades are within standards	93.4	99.5
Y5	Amount of roads minimized	76.6	98.1
Y6	Stream crossings minimized	79.7	94.2
Y7	Road excavation minimized	87.5	96.4
Y8	Excavated and fill materials placed properly	89.2	99.2
Y9	Roads constructed to drain well	92.9	98.7
Y10	Appropriate stabilization, drainage and diversions installed	99.2	100.0
	Overall Percentage	90.1	98.5

Table 12. Log landing BMP application and effectiveness for all state sites monitored.

Log landings A5-A7 were application challenges on state forests (Table 12). The A5 application rate was 76.6 percent, A6 was 79.7 percent, and Y7 87.5 was percent. However, each had high effectiveness rates at 98.1 percent, 94.2 percent and 96.4 percent, respectively.

Classified Forest Log Landings		% Applications	% Effective
Y1	Uses existing routes where appropriate	97.8	100.0
Y2	Adequate buffer strip next to watercourses and sensitive areas	87.2	97.7
Y3	Avoids unstable gullies, seeps, very poorly drained areas	95.7	100.0
Y4	Road grades are within standards	95.5	98.9
Y5	Amount of roads minimized	81.5	96.7
Y6	Stream crossings minimized	83.2	94.4
Y7	Road excavation minimized	95.1	96.7
Y8	Excavated and fill materials placed properly	92.0	98.9
Y9	Roads constructed to drain well	100.0	100.0
Y10	Appropriate stabilization, drainage and diversions installed	97.8	98.9
	Overall Percentage	92.6	98.3

Table 13. Log landing BMP application and effectiveness for all state sites monitored.

Classified forest also had three areas of log landing implementation challenges. Individual BMP application ratings were 87.2 percent for Y2, 81.5 percent for Y5 and 83.2 percent for Y6. However, each had effectiveness rates at 94.4 percent or above.

NIPF Landings		% Applications	% Effective
Y1	Uses existing routes where appropriate	98.2	99.1
Y2	Adequate buffer strip next to watercourses and sensitive areas	94.6	94.6
Y3	Avoids unstable gullies, seeps, very poorly drained areas	94.5	95.4
Y4	Road grades are within standards	96.0	98.0
Y5	Amount of roads minimized	88.1	91.7
Y6	Stream crossings minimized	91.6	91.6
Y7	Road excavation minimized	85.7	89.5
Y8	Excavated and fill materials placed properly	89.4	90.4
Y9	Roads constructed to drain well	96.3	99.1
Y10	Appropriate stabilization, drainage and diversions installed	89.8	92.6
	Overall Percentage	93.0	94.6

Table 14. Log landing BMP application and effectiveness for all NIPF sites monitored.

NIPF log landings need improvement in two areas – Y5 and Y7. There was an 88.1 percent application rate for landings avoiding collecting runoff. Proper water diversions were in working order 85.7 percent of the time. The effectiveness rates for each of these were a bit lower than in other ownerships but still acceptable at 91.7 percent and 89.5 percent, respectively.

Federal Log Landings		% Applications	% Effective
Y1	Uses existing routes where appropriate	83.3	100.0
Y2	Adequate buffer strip next to watercourses and sensitive areas	83.3	83.3
Y3	Avoids unstable gullies, seeps, very poorly drained areas	100.0	100.0
Y4	Road grades are within standards	100.0	100.0
Y5	Amount of roads minimized	66.7	83.3
Y6	Stream crossings minimized	83.3	100.0
Y7	Road excavation minimized	50.0	100.0
Y8	Excavated and fill materials placed properly	83.3	100.0
Y9	Roads constructed to drain well	100.0	100.0
Y10	Appropriate stabilization, drainage and diversions installed	100.0	96.4
	Overall Percentage	87.5	94.6

Table 15. Log landing BMP application and effectiveness for the 6 federal sites monitored.

Only six sites from federal lands were monitored. Therefore, any problem had much more impact on the final percentages. For this reason, only two areas were deemed to have implementation problems – Y5 and Y7 with application rates of 66.7 percent and 50 percent, respectively. The effectiveness rates for these two were acceptable at 83 percent and 100 percent respectively.

Industry Log Landings		% Applications	% Effective
Y1	Uses existing routes where appropriate	100.0	100.0
Y2	Adequate buffer strip next to watercourses and sensitive areas	100.0	100.0
Y3	Avoids unstable gullies, seeps, very poorly drained areas	100.0	100.0
Y4	Road grades are within standards	100.0	100.0
Y5	Amount of roads minimized	100.0	100.0
Y6	Stream crossings minimized	100.0	100.0
Y7	Road excavation minimized	N/A	N/A
Y8	Excavated and fill materials placed properly	100.0	66.7
Y9	Roads constructed to drain well	100.0	100.0
Y10	Appropriate stabilization, drainage and diversions installed	100.0	100.0
	Overall Percentage	100.0	96.2

Table 16. Log landing BMP application and effectiveness for the 3 industry sites monitored.

Log landings on the three industry sites that were monitored received near-perfect marks.

The only negative mark was in effectiveness for Y8 with all application scores and the remainder of effectiveness scores at 100 percent.

County Log Landings		% Applications	% Effective
Y1	Uses existing routes where appropriate	100.0	100.0
Y2	Adequate buffer strip next to watercourses and sensitive areas	100.0	100.0
Y3	Avoids unstable gullies, seeps, very poorly drained areas	100.0	100.0
Y4	Road grades are within standards	100.0	100.0
Y5	Amount of roads minimized	100.0	100.0
Y6	Stream crossings minimized	100.0	100.0
Y7	Road excavation minimized	100.0	100.0
Y8	Excavated and fill materials placed properly	100.0	100.0
Y9	Roads constructed to drain well	100.0	100.0
Y10	Appropriate stabilization, drainage and diversions installed	100.0	100.0
	Overall Percentage	100.0	100.0

Table 17. Log landing BMP application and effectiveness for the two county sites monitored.

Log landings were well managed on the two county sites. Application and effectiveness cores were 100 percent in all categories.

Skid Trails

Skid trails are always a demanding portion of any BMP implementation process because most of the harvest action is typically on difficult terrain.

Consequently, any scores above 80 percent will not be discussed in length in order to focus on areas with greater challenges.

Comprehensive Skid Trails		% Applications	% Effective
S1	Uses existing routes where appropriate	97.6	98.3
S2	Adequate buffer strip next to watercourses and sensitive areas	70.4	85.5
S3	Avoids steep and long straight grades (>20% for >200')	79.3	94.5
S4	Avoids unstable gullies, seeps, poorly drained areas	78.2	90.6
S5	Amount of skid trails minimized	82.9	95.1
S6	Trail excavation minimized	88.2	95.1
S7	Appropriate drainage and diversions installed	40.9	73.0
S8	Water diversions in working order	79.8	89.2
S9	Runoff diverted onto stable forest floor areas	71.2	78.4
S10	Streams not used as skid trails (except for crossings)	88.7	89.3
	Overall Percentage	77.9	89.1

Table 18. Skid trail BMP application and effectiveness for all 671 sites monitored from 1996 – 2011.

Across all sites monitored in the 16-year span covering all ownership types, skid trails had several areas of BMP implementation and effectiveness problems (Table 18).

S2 (Adequate buffer next to water courses and sensitive areas) scored 70.4 percent for application but 85.5 percent for effectiveness. S3 (Avoids steep and long grades) had a 79.3 percent application rate but 94.5 percent for effectiveness. S4 (Avoidance of seeps, gullies, poorly drained areas) had a 78.2 percent application rate and 90.6 effectiveness rate.

By far, S7 (Appropriate drainage and diversions installed) presented the most significant issue with an application rate of 40.9 percent and effectiveness rate of 73 percent. This indicates that a lack of adequate drainage and diversions did impact the water quality of some sites.

S8 (Water diversions in working order) had a 79.8 percent application rate and an 89.2 percent effectiveness rate. S9 (Runoff diverted onto stable forest floor areas) had a 71.2 percent application rate and a 78.4 percent effectiveness rate. This indicated that not properly directing runoff impacted water quality.

State Skid Trails		% Applications	% Effective
S1	Uses existing routes where appropriate	98.4	99.2
S2	Adequate buffer strip next to watercourses and sensitive areas	70.9	88.6
S3	Avoids steep and long straight grades (>20% for >200')	75.8	96.3
S4	Avoids unstable gullies, seeps, poorly drained areas	78.6	91.0
S5	Amount of skid trails minimized	80.5	94.7
S6	Trail excavation minimized	87.3	97.1
S7	Appropriate drainage and diversions installed	46.7	80.9
S8	Water diversions in working order	80.5	90.4
S9	Runoff diverted onto stable forest floor areas	67.6	75.1
S10	Streams not used as skid trails (except for crossings)	88.0	88.8
	Overall Percentage	77.3	89.9

Table 19. Skid trail BMP application and effectiveness for all state sites monitored.

BMP specifications S2 (70.9 percent), S3 (75.8 percent), S4 (78.6 percent), S7 (46.7 percent) and S9 (67.6 percent) all had application departures. Of those application problem areas, only two had effectiveness issues due to poor implementation. S7 (Appropriate drainage and diversions

installed) had an 80.9 percent effectiveness rate. S9 (Runoff diverted onto stable forest floor) had an effectiveness rating of 75.1 percent.

The comprehensive application rate for all skid trails monitored on State Forest properties is 77.3 percent, and the effectiveness rate is 89.9 percent.

Classified Forest Skid Trails		% Applications	% Effective
S1	Uses existing routes where appropriate	95.7	97.8
S2	Adequate buffer strip next to watercourses and sensitive areas	64.8	81.8
S3	Avoids steep and long straight grades (>20% for >200')	84.3	96.2
S4	Avoids unstable gullies, seeps, poorly drained areas	74.0	92.7
S5	Amount of skid trails minimized	88.7	96.9
S6	Trail excavation minimized	86.6	93.8
S7	Appropriate drainage and diversions installed	28.2	62.8
S8	Water diversions in working order	85.9	90.1
S9	Runoff diverted onto stable forest floor areas	76.4	84.7
S10	Streams not used as skid trails (except for crossings)	89.8	89.9
	Overall Percentage	77.7	88.9

Table 20. Skid trail BMP application and effectiveness for all CLFW sites monitored.

The main area of concern on Classified Forest skid trials was the installation of appropriate drainage and diversions (S7). The application rate of this BMP for Classified Forests was 28.2 percent and the effectiveness rate was 62.8 percent. These numbers indicate that implementation departures in this area are causing significant impacts to water quality on Classified Forest harvest sites.

Other skid trail BMPs in Classified Forests that need further attention are S2, S4 and S9. These have application rates of 64.8 percent, 74 percent and 76.4 percent, respectively. Effectiveness rates are 81.8 percent (S2), 92.7 percent (S4) and 84.7 percent (S9). These departures in application seem to have minimal effect on water resources of the sites.

NIPF Skid Trails		% Applications	% Effective
S1	Uses existing routes where appropriate	97.9	96.0
S2	Adequate buffer strip next to watercourses and sensitive areas	70.7	78.7
S3	Avoids steep and long straight grades (>20% for >200')	79.5	81.0
S4	Avoids unstable gullies, seeps, poorly drained areas	78.4	87.4
S5	Amount of skid trails minimized	83.6	91.4
S6	Trail excavation minimized	93.3	92.4
S7	Appropriate drainage and diversions installed	17.7	38.3
S8	Water diversions in working order	48.8	69.6
S9	Runoff diverted onto stable forest floor areas	68.8	78.1
S10	Streams not used as skid trails (except for crossings)	92.4	92.7
	Overall Percentage	75.9	82.3

Table 21. Skid trail BMP application and effectiveness for all NIPF sites monitored.

S7 was also a problem area for NIPF with an application percentage of 17.7 percent and effectiveness of 38.3 percent. This indicated a significant impact to water quality of NIPF sites due to lack of proper water drainage and diversions.

S8 (Water diversions in working order) was also a signification issue for NIPF. Application rate for water diversions in working order was 68.8 percent and effectiveness was 78.1 percent. Therefore, even on NIPF monitored sites that had water diversions installed, they were not working correctly due to installation, damage or other factors, rendering them inadequate at protecting water quality.

Other areas with application and effectiveness departures were S2, S3 and S4. Application rates were 70.7 percent, 79.5 percent, and 78.4 percent, respectively, with effectiveness rates of 78.7 percent, 81 percent, and 87.4 percent, respectively.

Federal Skid Trails		% Applications	% Effective
S1	Uses existing routes where appropriate	100.0	100.0
S2	Adequate buffer strip next to watercourses and sensitive areas	75.0	100.0
S3	Avoids steep and long straight grades (>20% for >200')	100.0	100.0
S4	Avoids unstable gullies, seeps, poorly drained areas	66.7	66.7
S5	Amount of skid trails minimized	66.7	83.3
S6	Trail excavation minimized	83.3	100.0
S7	Appropriate drainage and diversions installed	83.3	83.3
S8	Water diversions in working order	83.3	100.0
S9	Runoff diverted onto stable forest floor areas	100.0	100.0
S10	Streams not used as skid trails (except for crossings)	100.0	100.0
	Overall Percentage	80.0	92.7

Table 22. Skid trail BMP application and effectiveness for the six federal sites monitored.

The six federal sites monitored had three areas of skid trail implementation problems – S2, S4 and S5 – with respective application percentages of 75, 66.7 and 66.7, respectively. However, the effectiveness rate for S2 was 100 percent, showing no impact from inadequate buffers near watercourses and sensitive areas.

S4 had an effectiveness rate of 66.7 percent, indicating there was water quality impact due to the lack of avoidance of unstable gullies, seeps and other poorly drained areas. S4 effectiveness rate was 83.3 percent, indicating that although there were too many skid trails in some areas there wasn't a huge effect on water quality of the sites.

Industry Skid Trails		% Applications	% Effective
S1	Uses existing routes where appropriate	100.0	100.0
S2	Adequate buffer strip next to watercourses and sensitive areas	100.0	100.0
S3	Avoids steep and long straight grades (>20% for >200')	100.0	100.0
S4	Avoids unstable gullies, seeps, poorly drained areas	66.7	100.0
S5	Amount of skid trails minimized	66.7	100.0
S6	Trail excavation minimized	100.0	100.0
S7	Appropriate drainage and diversions installed	66.7	100.0
S8	Water diversions in working order	100.0	100.0
S9	Runoff diverted onto stable forest floor areas	66.7	100.0
S10	Streams not used as skid trails (except for crossings)	100.0	100.0
	Overall Percentage	84.0	100.0

Table 23. Skid trail BMP application and effectiveness for the 3 industry sites monitored.

Four skid trail BMPs needed improvement on the three industry sites monitored. S4, S5, S7 and S9 all had application rates of 66.7 percent. However, these departures in implementation seemed to cause no problem in effectiveness with all receiving scores of 100 percent.

County Skid Trails		% Applications	% Effective
S1	Uses existing routes where appropriate	100.0	100.0
S2	Adequate buffer strip next to watercourses and sensitive areas	0.0	100.0
S3	Avoids steep and long straight grades (>20% for >200')	100.0	100.0
S4	Avoids unstable gullies, seeps, poorly drained areas	0.0	100.0
S5	Amount of skid trails minimized	100.0	100.0
S6	Trail excavation minimized	50.0	100.0
S7	Appropriate drainage and diversions installed	100.0	100.0
S8	Water diversions in working order	100.0	100.0
S9	Runoff diverted onto stable forest floor areas	100.0	100.0
S10	Streams not used as skid trails (except for crossings)	50.0	100.0
	Overall Percentage	68.4	100.0

Table 24. Skid trail BMP application and effectiveness for the two county sites monitored.

In the two county sites monitored, there were some skid trail BMP implementation issues. Both sites did not leave an adequate buffer for water courses and sensitive sites as well as gullies, seeps and poorly drained areas. This led to 0 percent application scores for S2 and S4. However, both had 100 percent effectiveness rates, as did all other categories on county sites.

One site had problems with too much trail excavation (S6), resulting in an application score of 50 percent.

One site had a stream used as a skid trail, resulting in an S10 application score of 50 percent.

Effectiveness for both of these was 100 percent, showing no impact to water quality of the two sites due to these departures.

3. Stream Crossings

Comprehensive Stream Crossing		% Applications	% Effective
X1	Number of crossings minimized	88.0	90.0
X2	Crossings minimize disturbance to natural beds and banks	69.1	71.7
X3	Steam bank approaches properly designed and stabilized	59.8	63.8
X4	Water runoff diverted from road prior to crossing	48.4	55.7
X5	Crossing as close to 90 degrees as practicable	87.4	90.9
X6	Crossing does not unduly restrict water flow	84.3	85.2
X7	Soil has not been used as fill in the stream (except culverts)	83.2	83.2
X8	Ford constructed of non-erosive materials	88.5	87.9
X9	Fords have stable banks and streambeds	66.3	66.7
X10	Culverts are properly sized and installed	69.4	73.7
X11	Culverts clear of significant flow obstructions	80.0	83.3
X12	Temporary structures properly anchored	95.5	95.8
X13	Temporary structures and resulting obstructions removed	83.3	84.0
	Overall Percentage	76.3	78.6

Table 25. Stream Crossing BMP application and effectiveness for all 671 sites monitored.

Stream crossings have historically been the most challenging area of BMPs in Indiana. There is little margin of error for crossings. Mistakes are likely to result in a direct impact to water quality due to the proximity to water.

The overall stream crossing application rate for all ownership types was 76.3 percent and the effectiveness rate was 78.6 percent.

There are several problem areas for stream crossings across all landowner types. The first is X2, minimization of disturbance to natural bed and banks, with an application score of 69.1 percent and effectiveness score or 71.7 percent.

The proper design and stabilization of stream banks (X3) is a problem area, with an application score of 59.8 percent and effectiveness of 63.8 percent.

The stream crossing BMP with the most problems was X4, water runoff diverted from road prior to crossing. The application for X4 was 48.4 percent and effectiveness was 55.7 percent.

Improvement is also necessary in the area of fords having stable banks and streambeds (X9) with an application score of 66.3 percent and effectiveness of 66.7 percent.

X10 (Proper sizing and installation of culverts) also needs attention with an application score of 69.4 percent and effectiveness of 73.7 percent.

State Stream Crossing		% Applications	% Effective
X1	Number of crossings minimized	88.1	91.1
X2	Crossings minimize disturbance to natural beds and banks	74.6	78.6
X3	Steam bank approaches properly designed and stabilized	68.3	72.2
X4	Water runoff diverted from road prior to crossing	60.5	63.7
X5	Crossing as close to 90 degrees as practicable	87.3	92.1
X6	Crossing does not unduly restrict water flow	84.1	85.7
X7	Soil has not been used as fill in the stream (except culverts)	84.7	84.7
X8	Ford constructed of non-erosive materials	94.2	93.3
X9	Fords have stable banks and streambeds	66.0	65.0
X10	Culverts are properly sized and installed	61.1	66.7
X11	Culverts clear of significant flow obstructions	77.8	83.3
X12	Temporary structures properly anchored	100.0	100.0
X13	Temporary structures and resulting obstructions removed	85.7	85.7
	Overall Percentage	79.7	82.0

Table 26. Stream crossing BMP application and effectiveness for all state sites monitored.

State stream crossing problem areas closely mimicked the ones for overall stream crossings. X2, X3 and X4 all had low application and effectiveness rates. X9 and X10 also need further attention. X11 (Culverts clear of significant flow obstructions) was also a slight problem on state sites with an application rate of 77.8 percent and effectiveness rate of 83.3 percent. The state stream crossing application and effectiveness rates were several points higher than the overall rates.

Classified Forest Stream Crossing		% Applications	% Effective
X1	Number of crossings minimized	84.7	86.4
X2	Crossings minimize disturbance to natural beds and banks	60.0	60.0
X3	Steam bank approaches properly designed and stabilized	45.7	45.7
X4	Water runoff diverted from road prior to crossing	33.3	54.5
X5	Crossing as close to 90 degrees as practicable	88.6	91.4
X6	Crossing does not unduly restrict water flow	77.1	77.1
X7	Soil has not been used as fill in the stream (except culverts)	73.5	73.5
X8	Ford constructed of non-erosive materials	71.4	71.4
X9	Fords have stable banks and streambeds	60.7	57.1
X10	Culverts are properly sized and installed	85.7	85.7
X11	Culverts clear of significant flow obstructions	83.3	83.3
X12	Temporary structures properly anchored	100.0	100.0
X13	Temporary structures and resulting obstructions removed	80.0	80.0
	Overall Percentage	68.8	71.1

Table 27. Stream crossing BMP application and effectiveness for all CLFW sites monitored.

Classified forest stream crossings application and effectiveness were almost 11 percent below state crossings. Areas of concern were X2, X3, X4 and X9. Other areas of concern were X6, X7, and X8.

The crossing BMP with the lowest implementation and performance rates was X4 (Water runoff diverted from road prior to crossing) with an implementation rate of 33.3 percent and an effectiveness or performance rate of 54.5 percent.

X6 (Crossing not unduly restricting water flow) was not a huge problem but could use some improvement at 77.1 percent for both implementation and performance.

X7 and X8 had application and effectiveness ratings below 75 percent, and X9 (Fords have stable banks and streambeds) had an application score of 60.7 percent and an effectiveness score of 57.1 percent.

NIPF Stream Crossing		% Applications	% Effective
X1	Number of crossings minimized	88.0	87.8
X2	Crossings minimize disturbance to natural beds and banks	69.6	67.4
X3	Steam bank approaches properly designed and stabilized	46.7	51.1
X4	Water runoff diverted from road prior to crossing	20.0	30.0
X5	Crossing as close to 90 degrees as practicable	87.0	87.0
X6	Crossing does not unduly restrict water flow	84.7	87.0
X7	Soil has not been used as fill in the stream (except culverts)	93.3	93.3
X8	Ford constructed of non-erosive materials	93.1	93.1
X9	Fords have stable banks and streambeds	82.1	82.1
X10	Culverts are properly sized and installed	57.1	62.5
X11	Culverts clear of significant flow obstructions	66.7	71.4
X12	Temporary structures properly anchored	50.0	66.7
X13	Temporary structures and resulting obstructions removed	0.0	50.0
	Overall Percentage	73.1	74.8

Table 28. Stream crossing BMP application and effectiveness for all NIPF sites monitored.

NIPF stream crossings have the same problem areas of the other ownerships. X2 had an application rate of 69.6 percent and an effectiveness rate of 67.4 percent. X3 and especially X4 need extra attention. The X3 application rate was 46.7 percent and effectiveness was 51.1 percent. X4 was a significant problem area with 20 percent application and 30 percent effectiveness rate. Culverts were an area of concern here as well, with X10 application at 57.1 percent and effectiveness at 62.5 percent. There also were some issues with the few temporary structures employed on these NIPF sites. X12 has a 50 percent application rate and a 66.7 percent effectiveness rate. X13 has a 0 percent application rate and a 50 percent effectiveness rate.

Federal Stream Crossing		% Applications	% Effective
X1	Number of crossings minimized	100.0	100.0
X2	Crossings minimize disturbance to natural beds and banks	100.0	100.0
X3	Steam bank approaches properly designed and stabilized	100.0	100.0
X4	Water runoff diverted from road prior to crossing	N/A	N/A
X5	Crossing as close to 90 degrees as practicable	100.0	100.0
X6	Crossing does not unduly restrict water flow	100.0	100.0
X7	Soil has not been used as fill in the stream (except culverts)	100.0	100.0
X8	Ford constructed of non-erosive materials	N/A	N/A
X9	Fords have stable banks and streambeds	100.0	100.0
X10	Culverts are properly sized and installed	N/A	N/A
X11	Culverts clear of significant flow obstructions	N/A	N/A
X12	Temporary structures properly anchored	N/A	N/A
X13	Temporary structures and resulting obstructions removed	100.0	100.0
	Overall Percentage	100.0	100.0

Table 29. Stream crossing BMP application and effectiveness for the 6 federal sites monitored.

Stream crossings on federal sites were very well done with 100 percent in application and effectiveness on all applicable BMPs.

There were no stream crossings on industry or county sites.

4. Riparian Management Zones

Comprehensive Riparian Management Zones		% Applications	% Effective
Z2	Perennial & large intermittent streams clear of obstructing debris	68.5	71.7
Z3	Tree tops & cutoffs placed back from water course to prevent movement into streams during floods	86.3	92.3
Z4	RMZ free of excavated materials & debris (other than above)	93.1	95.8
Z5	Less than 10% bare mineral soil exposed within RMZ (not including crossings)	97.8	98.6
Z6	Adequate tree stocking in primary RMZ next to perennial streams	95.7	97.0
Z7	RMZ free of roads and landings (except crossing)	68.3	89.2
Z8	Water diverted from roads before entering RMZ	74.4	82.7
Z9	Water diverted into stable areas of the forest floor	83.2	87.5
Z10	Road and trail surfaces stabilized as needed within RMZ	85.4	87.8
Z11	Ephemeral channels free of excavating material	71.6	71.6
	Overall Percentage	81.7	86.8

Table 30. RMZ BMP application and effectiveness for all 671 sites monitored.

RMZs are a part of a timber harvest that has the potential to contribute pollution to the water resources of the site due to the close proximity of water. There is a satisfactory application and effectiveness rate of the BMPs in this area with an 81.7 percent and 86.7 percent.

Z2 (Perennial and large intermittent streams clear of debris) had a fairly low application rate at 68.5 percent and effectiveness rate at 71.7 percent.

Z7 (RMZ free of roads and landings) had a low implementation rate at 68.3 percent. However, this resulted in minimal impacts to water quality as the effectiveness rate was 89.2 percent.

Z8 (Water diverted from roads before entering RMZ) had an application rate of 74.4 percent and effectiveness of 82.7 percent. Z11 (Ephemeral channels free of excavated material) had application and effectiveness rates of 71.6 percent.

State Riparian Management Zones		% Applications	% Effective
Z2	Perennial & large intermittent streams clear of obstructing debris	68.4	70.6
Z3	Tree tops & cutoffs placed back from water course to prevent movement into streams during floods	89.9	94.1
Z4	RMZ free of excavated materials & debris (other than above)	94.0	96.9
Z5	Less than 10% bare mineral soil exposed within RMZ (not including crossings)	98.3	99.4
Z6	Adequate tree stocking in primary RMZ next to perennial streams	98.6	98.6
Z7	RMZ free of roads and landings (except crossing)	71.5	92.9
Z8	Water diverted from roads before entering RMZ	86.9	91.6
Z9	Water diverted into stable areas of the forest floor	88.3	92.2
Z10	Road and trail surfaces stabilized as needed within RMZ	92.1	92.9
Z11	Ephemeral channels free of excavating material	69.6	69.8
	Overall Percentage	84.3	88.9

Table 31. RMZ BMP application and effectiveness of all state sites monitored.

State RMZs were found to have higher application and effectiveness rates than the comprehensive RMZs.

Areas of RMZs on state land with challenges are Z2, Z7 and Z11. Obstructing debris in streams (Z2) was a problem with a 68.4 percent application rate and 70.6 percent effectiveness.

RMZs were not free of roads and landings on state lands (71.5 percent application), but had little impact to water quality due with an effectiveness rate of 92.9 percent.

More care is needed in keeping ephemeral channels free of excavated materials; application is 69.6 percent and effectiveness is 69.8 percent.

Classified Forest Riparian Management Zones		% Applications	% Effective
Z2	Perennial & large intermittent streams clear of obstructing debris	67.8	71.2
Z3	Tree tops & cutoffs placed back from water course to prevent movement into streams during floods	84.1	94.2
Z4	RMZ free of excavated materials & debris (other than above)	94.6	96.0
Z5	Less than 10% bare mineral soil exposed within RMZ (not including crossings)	98.7	98.7
Z6	Adequate tree stocking in primary RMZ next to perennial streams	91.3	95.7
Z7	RMZ free of roads and landings (except crossing)	50.0	76.4
Z8	Water diverted from roads before entering RMZ	55.1	77.6
Z9	Water diverted into stable areas of the forest floor	76.1	84.8
Z10	Road and trail surfaces stabilized as needed within RMZ	75.5	84.9
Z11	Ephemeral channels free of excavating material	80.7	79.5
	Overall Percentage	77.6	85.7

Table 32. RMZ BMP application and effectiveness of all CLFW sites monitored.

Classified forests had a more difficult time with application of RMZ BMPs, scoring over 4 percent below the comprehensive RMZs. However, the effectiveness rates were only about 1 percent less than the overall RMZ.

Problem areas were similar to state lands, but there were also several additional problem areas.

Obstructing debris in streams was still an issue with a 67.8 percent application and 71.2 percent effectiveness. RMZs were not free of roads and landings with a 50 percent implementation rate and effectiveness of 76.4 percent.

Water was not well diverted before entering RMZ (Z8) with application of 55.1 percent and effectiveness of 77.6 percent. When water was diverted it was not always diverted on to stable areas of the forest floor (Z9), 76.1 percent application and 84.8 percent effectiveness. Roads and trails were not always stabilized as needed within the RMZ (Z10) with an application rate of 75.5 percent and effectiveness rate of 84.9 percent.

NIPF Riparian Management Zones		% Applications	% Effective
Z2	Perennial & large intermittent streams clear of obstructing debris	69.1	76.4
Z3	Tree tops & cutoffs placed back from water course to prevent movement into streams during floods	64.1	77.4
Z4	RMZ free of excavated materials & debris (other than above)	86.3	89.0
Z5	Less than 10% bare mineral soil exposed within RMZ (not including crossings)	96.1	94.7
Z6	Adequate tree stocking in primary RMZ next to perennial streams	91.7	94.1
Z7	RMZ free of roads and landings (except crossing)	74.0	84.0
Z8	Water diverted from roads before entering RMZ	29.8	42.9
Z9	Water diverted into stable areas of the forest floor	54.8	60.6
Z10	Road and trail surfaces stabilized as needed within RMZ	70.2	71.9
Z11	Ephemeral channels free of excavating material	77.3	77.3
	Overall Percentage	73.9	78.7

Table 33. RMZ BMP application and effectiveness of all NIPF sites monitored.

NIPF RMZs were about 8 percentage points below the overall ratings for RMZs across all ownerships.

Z2 was again a problem area with 69.1 percent application and 76.4 percent effectiveness.

Z3 was an issue for the first time, with an application of 64.1 percent and effectiveness of 77.4 percent. Z7 had an application rate of 74 but and effectiveness of 84 percent, showing that although there were some roads and landings within RMZs that the impact was small.

The largest problem RMZs faced on NIPF is the diversion of water from roads before entry to RMZ (Z8). Application of this BMP was 29.8 percent and effectiveness was 42.9 percent. When water was diverted, it was often not diverted to stable forest floor (Z9), with an application of 54.8 percent and effectiveness of 60.6 percent.

Some road and trail surfaces needed further stabilization in the RMZ (Z10), with application at 70.2 percent and effectiveness at 71.9 percent. Multiple ephemeral channels were found to have excavated material in them (Z11) with application and effectiveness at 77.3 percent.

Federal Riparian Management Zones		% Applications	% Effective
Z2	Perennial & large intermittent streams clear of obstructing debris	100.0	100.0
Z3	Tree tops & cutoffs placed back from water course to prevent movement into streams during floods	100.0	100.0
Z4	RMZ free of excavated materials & debris (other than above)	100.0	100.0
Z5	Less than 10% bare mineral soil exposed within RMZ (not including crossings)	100.0	100.0
Z6	Adequate tree stocking in primary RMZ next to perennial streams	100.0	100.0
Z7	RMZ free of roads and landings (except crossing)	80.0	80.0
Z8	Water diverted from roads before entering RMZ	50.0	100.0
Z9	Water diverted into stable areas of the forest floor	100.0	100.0
Z10	Road and trail surfaces stabilized as needed within RMZ	100.0	100.0
Z11	Ephemeral channels free of excavating material	100.0	100.0
Overall Percentage		93.9	97

Table 34. RMZ BMP application and effectiveness of the 6 federal sites monitored.

RMZs were mostly very well done on the 6 federal sites monitored with a 93.9 percent application and 97 percent effectiveness rate.

The only two areas that were not perfectly implemented and performing were Z7 and Z8. Application and effectiveness for RMZs free of roads and crossings was 80 percent.

Half of the sites had problems with the diversion of water from roads before entering the RMZ however this caused no impact to water quality with a 100 percent performance rate.

Federal Riparian Management Zones		% Applications	% Effective
Z2	Perennial & large intermittent streams clear of obstructing debris	N/A	N/A
Z3	Tree tops & cutoffs placed back from water course to prevent movement into streams during floods	N/A	N/A
Z4	RMZ free of excavated materials & debris (other than above)	N/A	N/A
Z5	Less than 10% bare mineral soil exposed within RMZ (not including crossings)	N/A	N/A
Z6	Adequate tree stocking in primary RMZ next to perennial streams	N/A	N/A
Z7	RMZ free of roads and landings (except crossing)	N/A	N/A
Z8	Water diverted from roads before entering RMZ	N/A	N/A
Z9	Water diverted into stable areas of the forest floor	N/A	N/A
Z10	Road and trail surfaces stabilized as needed within RMZ	N/A	N/A
Z11	Ephemeral channels free of excavating material	100	100
	Overall Percentage	100	100

Table 35. RMZ BMP application and effectiveness of the 3 federal sites monitored.

There were no RMZs on the three monitored industry sites. RMZ BMP Z11 shows that the ephemeral channels on these sites were free of excavated materials with a 100 percent in application and effectiveness.

County Riparian Management Zones		% Applications	% Effective
Z2	Perennial & large intermittent streams clear of obstructing debris	N/A	N/A
Z3	Tree tops & cutoffs placed back from water course to prevent movement into streams during floods	N/A	N/A
Z4	RMZ free of excavated materials & debris (other than above)	N/A	N/A
Z5	Less than 10% bare mineral soil exposed within RMZ (not including crossings)	N/A	N/A
Z6	Adequate tree stocking in primary RMZ next to perennial streams	N/A	N/A
Z7	RMZ free of roads and landings (except crossing)	N/A	N/A
Z8	Water diverted from roads before entering RMZ	N/A	N/A
Z9	Water diverted into stable areas of the forest floor	N/A	N/A
Z10	Road and trail surfaces stabilized as needed within RMZ	N/A	N/A
Z11	Ephemeral channels free of excavating material	0	0
	Overall Percentage	0	0

Table 36. RMZ BMP application and effectiveness of the 2 county sites monitored.

There were no riparian management zones on the two county sites. The ephemeral channels on this site were both found to have soil in them, resulting in a 0 percent application and effectiveness score for this individual BMP.

V. Discussion

The overall forestry BMP application rate is 86.3 percent and overall effectiveness is 92.5 percent. The high application and effectiveness scores show there are many sound practices taking place throughout forest harvest sites to maintain the integrity of the soil and water resources.

However, in order to see the most improvement, BMPs with the most departures must be examined to determine how to best enhance the Indiana Forestry BMP Program.

The highlight of Indiana's Forestry BMPs in the last 16 years has been the high implementation and performance rates in the areas of access roads and log landings. Access road application and effectiveness rates were 94.6 percent and 98.3 percent, respectively. Log landings had a 91.2 percent application and 97.8 percent effectiveness rating.

Access road runoff drainage and diversion was the only real issue of concern; all still having an above 80 percent application rate overall and mid-90 percent effectiveness rates.

Log landings problem areas were the concentration or collection of runoff and the runoff diverted onto stable areas of forest floor. These areas also had application rates in the low 80 percent but effectiveness was above 93 percent, showing that impacts to water quality were minimal. All ownerships performed well on both of these forestry BMP categories.

Skid trails are where much of the work of a harvest occurs, so it is no surprise that many issues arise in this area. Skid trails had an overall application rate of 77.9 percent and effectiveness of 89.1 percent. This indicates that although there are some difficulties correctly implementing BMPs here, most do not result in impacts to water quality. Skid trails can have a spectrum of disturbance levels depending on how often equipment drives over a particular point on the ground.

For instance, the main trail just off the landing would have a higher disturbance level because all harvested logs have to be moved to the landing, while an area traveled over only twice – once to access trees and the other pulling the logs out – has a much lower level of disturbance. Also, skid trails go to areas that other equipment cannot access and cover more surface area across the harvest area. So, it may cross drainages, travel down or across hill slopes, or go into areas that are wet most of the time. Therefore, most of the application and effectiveness issues of a site are from skid trails. Also, most closeout practices are put in place with limited space as landforms and adjacent vegetation will often limit the equipment's ability to place structures where they would be most effective. This causes minor departures in application (20 percent of skid trail application scores are minor departures) with little to no effect on water quality.

Overall stream crossing BMP application is 76.3 percent, and overall effectiveness is 78.6 percent. Due to the nature of stream crossings, impacts to water quality are, at times, inevitable. However, the length and severity of impacts can be lessened if BMPs are applied properly. The best plan is to harvest in a way that avoids stream crossings, but that often is not a viable option.

The largest problem on stream crossings has been and continues to be the diversion of water before the stream crossing. This individual BMP (X4) had an overall application of 48.4 percent

and effectiveness of 55.7 percent. The ownership types that had the most problems in this area are private lands (Classified Forest and NIPF).

The proper design and stabilization of stream banks at crossings was also a problem area with an overall application of 59.8 percent and effectiveness of 63.8 percent. This problem also seemed more pronounced on sites of private land ownership.

RMZs are much like stream crossings because they are in close proximity to water bodies. If there is a problem, it often leads to direct impacts to water quality. So, managers often try to avoid placing high impact infrastructure like access roads or landings in RMZs unless they already exist.

RMZs had a respectable application rate at 81.7 percent. The effectiveness rate for overall RMZs was 86.7 percent.

The two main problem areas for RMZs were the presence of obstructing debris in perennials and large intermittent streams and the presence of excavated materials in ephemeral channels. Z2 – the RMZ BMP concerning obstructing debris – had an application rate of 68.5 percent and effectiveness of 71.7 percent overall. Z11, concerning excavated material in ephemeral channels, had an application and effectiveness rate of 71.7 percent.

One RMZ BMP – Z8 – had a large deviation of application and effectiveness rates between ownership types. Z8 is the BMP concerning water diversion before entry to the RMZ. On state lands, this particular BMP was well implemented and performed at 86.9 percent and 91.6 percent in application and effectiveness. On Classified Forest sites, the application and effectiveness of this BMP was much lower at 55.1 percent and 77.6 percent. It was even lower on NIPF sites with a 29.8 percent application and 42.9 percent effectiveness rate.

VI. Recommendations

- Concentrate training, education, and implementation on areas where problems are more common, such as skid trails, RMZs, and stream crossings.

- Continue to emphasize the importance of diverting water before it concentrates on roads, landings, skid trails and enters streams and RMZs. These types of BMPs were particularly challenging on private lands. Therefore, continuing education for private lands managers, owners and contractors is of distinct importance.

VII. Conclusions

Since 1996, the Indiana DNR Division of Forestry has provided forestry BMP leadership, training and implementation for private, industry, federal, county, municipal and state lands. The Division continues to hold itself and others to a high standard by continually monitoring timber harvests on state lands and other ownership types.

The forestry BMP standards developed by the Division and other stakeholders are revised and updated to reflect the current science. The Division holds itself to a higher standard by conducting a third-party audit of 10 percent of sites that were monitored in the previous year.

It is the Division's desire to use information found in reports such as this and other similar reports to raise awareness to the challenging areas of Forestry BMPs and to continue to improve in these areas.

Managing Indiana's timberlands for forest production, while maintaining the highest environmental quality, is of the utmost importance to the Division. Forestry BMPs are the means by which this can be accomplished.

Appendix A

BMP Definition Clarification – 4-Foot Rule

Background

The BMP Field Guide states, "Remove felled tops and logging debris from the channels of perennial and large intermittent streams."

On the BMP Monitor Sheet (expanded) the definition of the streams was further defined as "…wider than 6'…"

The purpose was to identify a specified width **for monitoring purposes** rather than leaving a vague descriptive term (e.g., large intermittent). It should be realized that BMPs are guidelines. In some instances even a 6-foot width may not be "large" while in other situations more narrow streams may be large from a hydrological standpoint.

Foresters therefore are expected to interpret the local hydrology and make on-site determinations when applying BMPs. This is clearly true for this BMP standard.

At the start of BMP monitoring on State Forests, it was decided to try to adhere to a tighter standard for streams on State Forests; hence the 4-foot standard for large intermittent streams. This would serve both as a demonstration of commitment to water quality and as a demonstration and test of a tighter standard.

Variable stream width cropped up as a problem early in this process, requiring clarification of stream width. Streams would widen out over four feet then narrow to less than four feet. This created a burden of trying to find the last point upstream that a stream was four-feet wide. To solve this, it was decided that in order to meet the 4-Foot Rule, a stream had to be consistently four-feet wide or wider. This solved some concerns, but there are other concerns, such as what debris needs to be removed and where a stream is consistently four-feet wide or wider.

Below is the latest attempt to clarify the 4-Four-Rule. This covers the definition of the stream and what debris is to be removed.

> **Removing Logging Debris from Streams – 4-Foot Rule**
>
> To meet the BMP Field Guide guidelines for riparian zones that states "Remove felled tops and logging debris from the channels of perennial and large intermittent streams," the BMP Monitor Sheet has Item Z2 "Perennial & large intermittent streams clear of obstructing debris." On state forests, all streams that are to meet this standard will have a clearly defined bed with a width that equals or exceeds four feet.
>
> The bed is that portion of the stream that is the lowest level where water commonly flows at typical (not storm) levels. This generally will be at the base of the banks and will

usually consist of aggregate or exposed alluvium. The bed generally will be free of any significant vegetation because of the regular scouring and water flows. An area with a strong, well-rooted vegetative component with a relatively stable soil surface will not be considered streambed. In streams where the channel is strewn with large rocks, the bed will be the area of smaller gravel at the base of the large rocks.

The stream will be considered four feet or wider until the bed, moving upstream, reaches the first point where the stream bed width drops below four feet for a lineal distance of 10 feet or more. Any portion of the drainage system up stream of this point will not be subject to the debris removal guidelines for large intermittent streams, and debris left in these portions of the drainage will not be considered a departure during monitoring.

Downstream of the identified four-foot-wide point, all logging debris, except as noted below, that will come in contact with the water when the stream is "bank full" and impede or divert stream flow must be removed from the stream channel. Unattached, individual pieces of debris less than two inches in diameter or less than four feet in length ordinarily will not impede flow and does not need to be removed. Debris that bridges the stream channel from top of bank to top of bank, does not impede flow, and is unlikely to fall into the stream channel within one year is not required to be removed. Debris less than two inches in diameter obstructing less than 20 percent of the stream channel does not need to be removed.

Debris removal is to be accomplished in a manner that minimizes disturbance to the stream banks. The recommended method of removal is to pull the material free of the channel using a cable skidder or other equipment that is kept back from the stream edges. Another option is to cut debris into smaller pieces that can be removed from the channel or would no longer impede flow. Equipment should not be used in the stream channel to push the material out of the channel. Careful marking of the trees to be harvested, use of directional felling, and clearly explaining the BMP requirements during the pre-harvest conference will minimize the amount of debris that must be removed from stream channels.

The point where the stream channel reaches the four-foot width threshold should be clearly delineated in harvest areas. While upstream of this point will not be considered subject to debris removal from streams, care should be taken to avoid excessive, intentional deposition of debris in all naturally occurring drainage features regardless of size. Excessive piling (beyond felling) of debris in any drainage that severely impedes flow may be considered a departure.

Appendix B

FORESTRY BMP MONITORING WORKSHEET (2000)

DATE INSPECTED:_____TEAM:_____

OWNER:_____ PHONE:_____.

_____

_____

COUNTY:_____Site #:_____ ACRES HARVESTED:_____

CIVIL TWP:_____ USGS QUAD:_____

SEC:_____TWP:_____ RANGE:_____

MAJOR WATERSHED:_____

DATE OF ACTIVITY:_____

HARVEST EQUIPMENT USED: Dozer:__ Skidder:__ Horses:__ Other:__

TYPE OF HARVEST: Diameter limit:__ Single Tree:__ Group Selection:__ Clear Cut:__ Other:__

SITE CONDITIONS

TERRAIN: BOTTOMLAND_____% RIDGES_____% SIDE SLOPES_____%

SLOPE STEEPNESS: (2-6%)_____ (6-12%)_____ (12-20%)_____ (20+%)_____

LAKES PRESENT: name:_____shore length:_____

PERENNIAL STREAMS PRESENT: name:_____width:_____length:_____

SINKHOLES PRESENT: Yes_____ No_____ FLOWING SPRINGS PRESENT: Yes_____ No_____

OPEN WATER WETLANDS PRESENT: Yes_____ No_____ .

FOR OFFICE USE – DO NOT COMPLETE

OPERATOR/FORESTER: (leave blank)_____

TYPE OF OWNERSHIP: nipf:__ clf:__ industry:__ state:__ fed:__ county:__ other:__

APPLICATION	EFFECTIVENESS
0--The Practice Not Needed or Applied on Site	1--Adequate Protection of Water Resources.
1--Operation Meets Requirement of Bmp	2--Indirect and Temporary Impacts on Water Resources.
2--Minor Departure from Bmp	3--Indirect and Prolonged Impacts on Water Resources.
3--Major Departure from Bmp	4--Direct and Temporary Impacts on Water Resources.
4--Gross Neglect of Bmp	5--Direct and Prolonged Impacts on Water Resources.

APPLICATION DEFINITIONS (BY EXAMPLE)

MINOR DEPARTURE: Practice not clearly needed; attempted practice but poorly applied; small potential for soil to reach streams.

MAJOR DEPARTURE: Practice clearly needed; common departures from practice; large potential for soil to reach streams.

GROSS NEGLECT: No attempt at application; total disregard for water quality; large and direct impacts.

EFFECTIVENESS DEFINITIONS (BY EXAMPLE)

ADEQUATE: Small amount of material eroded; material does not reach drainages, streams, lakes or sinkhole openings.

INDIRECT IMPACT: Erosion and delivery of material to drainages (including ephemerals) but not to intermittent or perennial streams, lakes or sinkhole openings.

DIRECT IMPACT: Erosion and subsequent delivery of sediment to intermittent or perennial streams, lakes or sinkhole openings.

TEMPORARY IMPACT: Impacts lasting one year or less; no more than one runoff season; small amount of material involved.

PROLONGED IMPACT: Impacts lasting more than one year; large amount of material involved.

***It is possible to have a departure from BMPs and still have adequate protection.**

ACCESS ROADS							APPLICATION (0-4)		
								EFFECTIVENESS (1-5)	
								COMMENTS	
There is no access road present _____ (If true, do not answer questions below)									
A1. Uses existing routes where appropriate									
A2. Adequate buffer strip next to watercourses and sensitive areas									
A3. Avoids unstable gullies, seeps, very poorly drained areas									
A4. Road grades are within standards									
A5. Amount of roads minimized									
A6. Stream crossings minimized									
A7. Road excavation minimized									
A8. Excavated and fill materials placed appropriately									
A9. Roads constructed to drain well									
A10. Appropriate road stabilization, drainage & diversions installed									
X=applied	water bars_____ dips/rolls_____ outslopes_____ berms cut_____ culverts____ geotextile____ rock____ seed____ mulch_____								
A11. Water diversions are in working order (_____% working) Failure due to: installation, damage, location, timing, weather, other									
A12. Runoff diverted onto stable forest floor areas									
A13. Mud kept off public roadways									
A14. Public road drainage system maintained									
A15. Appropriate traffic barriers installed									

APPLICATION

0--The Practice Not Applicable

1--Operation Meets Requirement of Bmp

2--Minor Departure from Bmp

3--Major Departure from Bmp

4--Gross Neglect of Bmp

EFFECTIVENESS

1--Adequate Protection of Water Resources.

2--Indirect and Temporary Impacts on Water Resources

3--Indirect and Prolonged Impacts on Water Resources.

4--Direct and Temporary Impacts on Water Resources.

5--Direct and Prolonged Impacts on Water Resources.

APPLICATION DEFINITIONS (BY EXAMPLE)

MINOR DEPARTURE: Practice not clearly needed; attempted practice but poorly applied; small potential for soil to reach streams

MAJOR DEPARTURE: Practice clearly needed; common departures from practice; large potential for soil to reach streams

GROSS NEGLECT: No attempt at application; total disregard for water quality; large and direct impacts

EFFECTIVENESS DEFINITIONS (BY EXAMPLE)

ADEQUATE: Small amount of material eroded; material does not reach drainages, streams, lakes or sinkhole openings.

INDIRECT IMPACT: Erosion and delivery of material to drainages (including ephemerals) but not to intermittent or perennial streams, lakes or sinkhole openings.

DIRECT IMPACT: Erosion and subsequent delivery of sediment to intermittent or perennial streams, lakes or sinkhole openings.

TEMPORARY IMPACT: Impacts lasting one year or less; no more than one runoff season; small amount of material involved.

PROLONGED IMPACT: Impacts lasting more than one year; large amount of material involved.

***It is possible to have a departure from BMPs and still have adequate protection.**

LOG LANDINGS									
							APPLICATION (0-4)		
								EFFECTIVENESS (1-5)	
									COMMENTS
Y1. Suitable number and size of landings									
Y2. Landings located outside RMZ									
Y3. Landings located on stable areas									
Y4. Excavation of site minimized									
Y5. Landings avoid concentrating or collecting runoff									
Y6. Landing's runoff enters stable area									
Y7. Proper water diversions in working order									
Y8. Landing smoothed and soil stabilized									
Y9. Landings free of fuel and lubricant spills and litter									
Y10. Landing location suitable for equipment fueling and maintenance									
Number of log landings _____ Size: (acres) _____.									

APPLICATION **EFFECTIVENESS**

0--The Practice Not Applicable

1--Operation Meets Requirement of Bmp

2--Minor Departure from Bmp

3--Major Departure from Bmp

4--Gross Neglect of Bmp

1--Adequate Protection of Water Resources.

2--Indirect and Temporary Impacts on Water Resources.

3--Indirect and Prolonged Impacts on Water Resources.

4--Direct and Temporary Impacts on Water Resources.

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ADEQUATE: Small amount of material eroded; material does not reach drainages, streams, lakes or sinkhole openings.

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SKID TRAILS												
							APPLICATION (0-4)					
								EFFECTIVENESS (1-5)				
									COMMENTS			
S1. Uses existing routes where appropriate												
S2. Adequate buffer strip next to watercourses & sensitive areas												
S3. Avoids steep and long straight grades (>20% for >200')												
S4. Avoids unstable gullies, seeps, poorly drained areas												
S5. Amount of skid trails minimized												
S6. Trail excavation minimized												
S7. Appropriate drainage and diversions installed												
X= applied	water bars____ outslopes____ dips/rolls____ berms cut____ culverts____ seed____ mulch____ rock____ other____											
S8. Water diversions in working order (_____% working)Failure due to:installation, damage, location, timing, weather, other												
S9. Runoff diverted onto stable forest floor areas												
S10. Streams not used as skid trails (except crossings)												
Types of streams involved and length of disturbance: perennial_____ , mapped intermittent_____. Unmapped intermittent_____ , ephemeral_____.												

APPLICATION **EFFECTIVENESS**

0--The Practice Not Needed or Applied on Site

1--Operation Meets Requirement of Bmp

2--Minor Departure from Bmp

3--Major Departure from Bmp

4--Gross Neglect of Bmp

1--Adequate Protection of Water Resources.

2--Indirect and Temporary Impacts on Water Resources.

3--Indirect and Prolonged Impacts on Water Resources.

4--Direct and Temporary Impacts on Water Resources.

5--Direct and Prolonged Impacts on Water Resources.

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EFFECTIVENESS DEFINITIONS (BY EXAMPLE)

EFFECTIVENESS DEFINITIONS (BY EXAMPLE)

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RIPARIAN MANAGEMENT ZONES			
	APPLICATION (0-4)		
		EFFECTIVENESS (1-5)	
			COMMENTS
Z1. RMZ present on this site include: _____ lakes, _____ rivers, _____ perennial streams, _____ intermittent streams, _____ sinkhole openings (specify), _____ open water wetlands, _____ unmapped intermittent streams			
Z2. Perennial & large intermittent streams clear of obstructing logging debris			
Z3. Logging debris placed back from watercourseto prevent movement into streams during floods			
Z4. RMZ free of piled slash, debris and fill			
Z5. Less than 10% bare mineral soil scattered within RMZ - not including crossing			
Z6. Adequate tree stocking in primary RMZnext to perennial streams			
Z7. RMZ free of roads and landings (except crossings)Were roads pre-existing? _____			
Z8. Water diverted from roads before entering RMZ			
Z9. Water diverted onto stable areas of the forest floor			
Z10. Road and trail surfaces stabilized as needed within RMZ			
Z11. Ephemeral channels free of excavated material			

APPLICATION	EFFECTIVENESS
0--The Practice Not Needed or Applied on Site	1--Adequate Protection of Water Resources.
1--Operation Meets Requirement of Bmp	2--Indirect and Temporary Impacts on Water Resources.
2--Minor Departure from Bmp	3--Indirect and Prolonged Impacts on Water Resources.
3--Major Departure from Bmp	4--Direct and Temporary Impacts on Water Resources.
4--Gross Neglect of Bmp	5--Direct and Prolonged Impacts on Water Resources.

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SUPPLEMENTAL QUESTIONS AND SUMMARY

1) WHAT WENT RIGHT ON THIS SITE? (SUMMARIZE HIGHLIGHTS)

2) WHAT WENT WRONG ON THIS SITE? (SUMMARIZE PROBLEMS)

3) HAVE OTHER ACTIVITIES OCCURRED ON THIS SITE THAT POTENTIALLY IMPACT WATER QUALITY? (E.G**. ATV use, vehicle traffic, grazing, etc.)**

If so, please explain.

4) WERE TRAFFIC BARRIERS IN PLACE TO PREVENT TRESPASS DAMAGE? _____.

WHAT KIND OF TRESPASS DAMAGE WAS OBSERVED?

5) ARE THERE MITIGATING ACTIVITIES THAT SHOULD TAKE PLACE ON THIS SITE OR IS CORRECTIVE ACTION ALREADY BEING TAKEN.

6) -HAS THE SALE ADMINISTRATOR RECEIVED BMP TRAINING? Yes_____ No_____Unknown_____.

- HAS THE OPERATOR (LOGGER) RECEIVED ANY BMP TRAINING? Yes_____ No_____Unknown_____.

- WAS THE SALE ADMINISTERED BY A FORESTER? Yes_____ No_____Unknown_____.

- IS THE LANDOWNER AWARE OF BMPs? Yes_____ No_____Unknown_____.

7) GIVE THIS SITE AN OVERALL RATING OF 1-8 COMBINING APPLICATION OF BMPs WITH IMPACT TO WATER QUALITY.

RATE THIS SITE FROM 1-4 FOR THE OVERALL APPLICATION OF BMPs _____

1=above average 2=average 3=poor 4=total negligence

RATE THIS SITE FROM 1-4 FOR ITS OVERALL IMPACT TO WATER QUALITY _____

1= no visible impact 2=slight 3=moderate 4=severe

SITE RATING _____/2=_____

Note: These numbers do no necessarily need to directly reflect the worksheet ratings for application or effectiveness

Field Guide Cross Reference

On this page is each question in the monitoring sheet and the corresponding pages on the subject in the BMP Field Guide.

ACCESS Roads == Section II, pages 8-16

A1 == pages 4, 8, 10

A2 == pages 8, 9, 12, Section V page 32, 33, Table 4 page 34, 35

A3 == page 8

A4 == page 8

A5 == page 10

A6 == page 8 and Section IV page 24 – 30

A7 == pages 8, 10

A8 == pages 10, 12, 24, 29

A9 == pages 8, 10, Table 1 page 11, 12

A10 = pages 8, 10 Table 1 page 11, 12, 14, 15, Table 2 page 21, 22

X=Applied == (waterbars, pages 21-22), (dips/rolls, pages 21-22), (outslopes, Glossary), (berms cut, Glossary), (culverts, pages 27-28), (geotextile, Glossary), (rock, page 10), (seed, Appendix A), (mulch, Appendix A).

A11 = pages 14, 15, Table 1 page 11, 18, Table 2 page 21

A12 = page 10

A13 = pages 13, 14

A14 = page 14

LOG LANDINGS == Section IV, pages 36-40

Y1 == pages 36, 39

Y2 == Table 4 page 34, 36

Y3 == page 36

Y4 == page 38

Y5 == pages 36, 38-40

Y6 == pages 38-40

Y7 == pages 38-40

Y8 == pages 38-40

Y9 == pages 39, 40

Y10 = page 39

SKID TRAILS == Section III, pages 18-22

S1 == pages 4, 18

S2 == pages 18, 20, Section V pages 32-35

S3 == page 18

S4 == page 18

S5 == page 18

S6 == page 18

S7 == Table 1 page 11, pages 18-20, Table 2 page 21, 22, 27, 28

X=Applied == (waterbars, pages 21-22), (dips/rolls, pages 21-22), (outslopes, Glossary), (berms cut, Glossary), (culverts, pages 27-28), (geotextile, Glossary), (rock, page 10), (seed, Appendix A), (mulch, Appendix A).

S8 == Table 1 page 11, pages 14, 15, 20 Table 2 page 21

S9 == page 20

S10 = pages 18-20, Section IV pages 24-30

Types of Streams == page 24, Glossary, and Section V pages 32-35

STREAM CROSSINGS == Section IV, pages 24-30

X1 == page 24

X2 == page 24

X3 == pages 24, 25

X4 == pages 24, 25

X5 == page 24

X6 == pages 24-26, 28

X7 == pages 24, 29

X8 == pages 24, 29

X9 == pages 24, 25, 29

X10 = pages 25, 27, Table 3 page 28

X11 = pages 24, 27, 28

X12 = pages 25, 26

X13 = pages 25-29

RIPARIAN MANAGEMENT ZONES == Section V, pages 32-35

Z1 == pages 32, 34, Glossary

Z2 == page 33

Z3 == pages 32-34

Z4 == pages 32-34

Z5 == pages 32-34

Z6 == pages 32-34

Z7 == pages 32, 34

Z8 == pages 33, 34

Z9 == pages 32-34

Z10 = pages 33, 34

Z11 = page 35